XVII. *On the Corpuscles of the Blood.—Part III.* *By* MARTIN BARRY, *M.D.*, *F.R.SS. L.* and *E.*

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NOTWITHSTANDING the great length of time during which the blood has been the subject of physiological research, an eminent anatomist, so late as the year 1838, remarks, that "we have no clear conception of the mode in which the floating corpuscles of the blood conduce to nourishment†." That Professor WEBER was not mistaken in coming to such a conclusion, I think will be admitted by every one who takes the pains to consult the records of discovery in this most interesting field of observation.

I am not aware that, since the period just mentioned, any additional facts have been published, relating to "the mode in which the floating corpuscles of the blood conduce to nourishment," unless my own communications, already presented to the Society‡, are to be so regarded,—those communications having reference to the mode of propagation of the floating blood-corpuscle, and to its conversion into two or three kinds of tissues.

The object of the present memoir is to bring together a large number of observations, made by myself, showing that every structure I have examined arises out of corpuscles having the same appearance as corpuscles of the blood. I may here mention, that the tissues submitted to actual observation, with the result just mentioned, will be found to include the cellular, nervous, and muscular; besides cartilage, the coats of blood-vessels, several membranes, the tables, cells, and cylinders of the epithelium, the pigmentum nigrum, the ciliary processes, the crystalline lens itself, and even the spermatozoon and the ovum. And among the vast number of observations made, I have not been able, with the greatest care, to detect a single fact inconsistent with the conclusion above announced. If that conclusion—which regards the *formation* of the tissues—be correct, it may, I think, assist us in considering "the mode in which the floating corpuscles of the blood conduce to nourishment" *during life.*

For the detail of these observations, I shall rely principally upon the drawings, and the minute explanation of them separately given. The perusal of that explanation will, I conceive, be necessary for the understanding of some general remarks I shall

† E. H. WEBER, in MÜLLER'S Archiv, 1838, p. 463.

‡ On the Corpuscles of the Blood. Philosophical Transactions, 1840, Part II. p. 595: and Part II. on the same subject, in the present volume, p. 201.

have to offer: and I can scarcely expect the reader to admit the conclusions drawn, until he is in possession of the unequivocal evidence, to be derived in no other way than by a close examination of the Plates, in connection with the explanation just referred to.

I may here mention, that it is not my object in this memoir, to trace the tissues investigated into a perfectly formed state; but simply to present such of their earliest stages, as show them to be derived from objects having the same appearance as corpuscles of the blood. In so doing, I shall have to mention a variety of facts, which, though met with incidentally, and recorded without remark, may not be considered destitute of physiological interest.

88. It is important that any one disposed to repeat the following observations, should, before entering upon them, carefully notice the colour,—the transparent yellow colour,—of the corpuscles of the blood, viewed singly, with a high magnifying power (as, for example, the corpuscles in blood obtained by a puncture of the finger); so that when the same colour is met with elsewhere, he may recognize it. The yellow of the magnified corpuscle as thus singly viewed, is obviously that which gives to the mass of blood—seen with the naked eye, and by reflected light—its well-known red. The reader will bear this in mind, when colour is spoken of in the following memoir.

89. Some of the observations I am about to communicate, will be found at variance with those of other investigators in general anatomy, not excepting even the most recent. I have not room, within the limits of a paper, to introduce the opinions of the authors referred to.

90. On former occasions, I have mentioned a certain minute structure, under the denomination *disc*. As the same term will be constantly employed in this memoir, it is better, once for all, to define it, as a flat, elliptical or circular body; usually having a concavity in the middle of the flat surface (fig. 141 δ, δ, ε.). Frequently, however, these minute bodies lose their elliptical or circular form, and assume, as if by pressure, a polyhedral shape; and, in certain states, the concavity becomes an orifice. There are also conditions in which a minute projection is presented at this part. Numerous examples of discs are to be found in almost every figure which accompanies the paper.

91. The *disc* seems in many instances to correspond to the "cytoblast" of Schleiden; though his description of the "cytoblast" differs in some material points from the definition I have given of the disc†: and our experience of the destination of these objects is no less different. In the proper place it will be shown that the disc has been described by some as a peculiar object, found in two or three kinds of globules.

92. By *division into discs*, an expression frequently made use of in this paper, I do not mean simple separation. For, from the analogy which seems to exist between the mode of propagation of the blood-corpuscle, and that of the cells which are the immediate successors of the germinal vesicle in the ovum, there cannot be a doubt

† See Third Series on Embryology, Philosophical Transactions, 1840, Part II. pars. 385, 425.

but that, in all instances, and whatever the minuteness of the object, the division in question takes place by a similar process,—a process which we found to be elaborate in the extreme.

93. The expression, *having the same appearance as the corpuscles of the blood,* is constantly made use of in the following pages; though most of the corpuscles to which it is applied would have been at once denominated corpuscles of the blood, but for a reason given in the concluding portion of the memoir (par. 196.).

94. Besides the substances above mentioned, I have examined the pus and mucus globules, which I shall first describe.

The Globules of Pus derived from Corpuscles of the Blood:—Mucus-globules compared with them.

95. "The nucleus of the mucus-corpuscle," says SCHWANN, "has the peculiarity, discovered by GÜTERBOCK, of becoming separated into two or three corpuscles of minuter size by acetic acid; while the surrounding part is gradually dissolved by this reagent. VOGEL supposes this property to belong only to pus-corpuscles, and to the corpuscles of unhealthy mucus. HENLE, however, informs me," continues SCHWANN, "that the same peculiarity *** is found in the true mucus-corpuscles, present in healthy mucus†." Respecting pus-corpuscles, SCHWANN remarks, "They share with them [corpuscles of mucus] the peculiar relation towards acetic acid‡."

96. My own observations on this subject are the following. In Plate XX. fig. 64 β. are pus-globules, to which no addition whatever had been made; and fig. 63 ζ presents one of these globules, as viewed after the addition of dilute spirit. Now as the objects in both figures exhibit the division of the "nucleus," just spoken of, without the addition of acetic acid, I am compelled to form an opinion opposed to that of the authors just referred to, and to maintain that in the pus-globule acetic acid is not required to produce such division.

97. But facts recorded in several of my former memoirs appear to have been sufficient for showing that neither acetic acid nor any other foreign substance is required to produce division of what has been called the nucleus of the pus-globule; such division being part of the process by which cells are reproduced, and apparently universal in its operation. The present memoir, also, will be found full of facts, showing that this really is the case.

98. As to the mode of origin of the objects in question, SCHWANN remarks, "The pus-corpuscles are thus probably peculiar cells, forming in the pus-serum, that is in the cytoblastema, which in inflammation exudes in greater quantity and unusual mixture, in the same manner as the mucus-corpuscles form in mucus, and as all cells

† Mikroskopische Untersuchungen über die Uebereinstimmung in der Struktur und dem Wachsthum der Thiere und Pflanzen, 1839, pp. 77, 78.

‡ *L. c.*, pp. 78, 79.

form in their cytoblastema. Their formation appears, according to the observations of H. Wood, to take place first at the surface of the granulations†."

99. The latest published view I am acquainted with, as to the mode of origin of pus and mucus-globules, is that of Dr. Mandl‡, with whom it appears to have been a principal object to point out the relation between these globules and the blood. This author considers the globules of pus and mucus as identical; but that they can by no means be regarded as altered corpuscles of the blood; for he supposes that the latter, by contact with pus, are dissolved. As to the nature of the globules of pus and mucus, he states them to be "fibrinous globules," such as those which he was the first to describe. He thinks that the blood passes through the walls of its vessels, with all its elements except the corpuscles, which cannot be thus transuded; and that the liquor sanguinis which contains the fibrin in solution, thus placed out of the circulation, gives origin to a coagulation of the fibrin; and, as the serum itself transudes only drop by drop, it is in drops that the fibrin coagulates; thus forming the corpuscles known by the name of globules of pus, mucus, &c.§.

100. The following are my own observations on this subject; altogether differing, it will be seen, from those just referred to.

101. Fig. 63. represents objects seen in fluid of a blood-red colour‖, from an abscess in the human subject, to which fluid no addition had been made. The field of view was occupied by myriads of young blood-corpuscles, among which were seen all the states represented in this figure. Proceeding through the figure in the order in which the objects are alphabetically lettered, we find the corpuscle of the blood—known to be discoid in its form—gradually assuming an orange shape, and finally becoming globular. Then, however, it is not the entire corpuscle, but the enlarged nucleus of the same. In the situation of the depression in the original blood-disc, there is now seen a pellucid orifice (α). This orifice appears to be at first round. It either continues of this form,—or it elongates,—or becomes triangular (β). A reddish substance, stretching across the orifice, divides it, when elongated into two, and when triangular into three orifices (γ). The intervening substance seems to become more consistent (δ); many minuter orifices come into view,—apparently the pellucid centres of as many discs, the outlines of which discs are hidden by red colouring matter (ε); and, finally, on the extreme right in the figure, we have the formed pus-globule (ζ).

102. From this observation, with others, I am induced to believe that the pus-globule is the altered nucleus of a corpuscle of the blood.

103. The microscopical appearance of pus-globules is pretty generally known. Dr. Vogel gave me drawings of them, accompanied by a description, from his own observations, in 1837; and I have not seen them more accurately delineated or described by any subsequent observer. "They are uneven at the surface," says Dr.

† Schwann, *l. c.*, p. 79. ‡ Gazette Médicale de Paris, 4 Juillet, 1840. § *L. c.*, p. 419.

‖ Furnished by my friend William Marten Cooke, M.B.

Vogel, "being covered with minute granules; and with the addition of acetic acid they undergo a peculiar change. There then appear simple granules, generally two or three in each pus-globule (rarely one only or four), which are oval or roundish, having for the most part a somewhat projecting margin, giving them almost a basin-shaped appearance. They are surrounded by a delicate halo or covering, which, with the continued influence of acetic acid, entirely disappears, so that the isolated granules remain alone†." The numerous observations of Gulliver on pus, are deserving of attention‡. This author, however, describes the "molecules" (the term he uses) as spherical, and as "*centrically* inclosed in an external part;" and he does not mention the depression which each of these "molecules" presents.

104. My own views of the pus-globule are in some respects peculiar. The formation of this object out of the nucleus of the blood-corpuscle, appears to me to be referable to the same process, essentially, as that by means of which the germinal spot comes to fill the germinal vesicle, in the ovum. This process having been particularly described in a former memoir§, I need not refer to it in detail here. Its effects are seen progressing in fig. 63, and they have been rendered more obvious by acetic acid, and by alcohol in fig. 64. In the latter figure, an originally single nucleus consists, for the most part of two, in one instance of three, layers of discs or incipient cells; the highly refracting (and probably most essential) portion being, as in all other nuclei, the part formed last.—That the term *nucleus* is here not inappropriate, as applied to the pus-globule, will I presume be admitted, should others, before adding any foreign substance, find the pus-globule to be contained within a cell, as frequently as I have noticed this to be the case. If so, however, the highly refracting discs form together, not the "nucleus," as they have been called, but the nucleolus.—It will be seen that I differ from previous observers, in considering the *outer* portion of the pus-globule to be composed of discs or incipient cells. But this is only one of many differences between the observations here recorded, and those of other investigators.

105. I have already stated that the object called by me the *disc*, had in several instances been described by some as a peculiar structure found in two or three kinds of globules. The term *disc* is synonymous with the "basin-shaped granules" of Vogel, and the "spherical molecules" of Gulliver, seen in the globule of pus; the same object having been observed also by Güterbock, Henle, and others who have investigated the structure of the pus-globule.

106. The condition of portions of a capillary network, which I have found in pus, —a minute fragment of which, in outline, is represented in fig. 65,—confirms the

† Dr. Vogel has since published a work entitled "Physiologisch-pathologische Untersuchungen über Eiter, Eiterung, &c." Erlangen, 1838, which, however, I have not seen.

‡ London Medical Gazette, 1839, 1840. Medico-Chirurgical Transactions, 1840.

§ Researches in Embryology: Third Series. Philosophical Transactions, 1840, Part II. par. 385.

idea recorded in my first communication on the corpuscles of the blood†, namely, that the appearance of these corpuscles in inflammation is the same as that which they present in vital turgescence of the vessels; an appearance which seems to be referable to changes effected by a process of the same kind as that above referred to. In such portions of capillary network, the corpuscles are found to have assumed the same colour as the pus-globules. The fragment in question contained what seemed to be a pus-globule at a certain part; and very possibly the other corpuscles in this vessel had been destined to furnish globules of pus. The occurrence, however, of pus-globules in the blood-vessels, I am aware is by no means new.

107. "According to HENLE," says SCHWANN, "the corpuscles of pus are not distinguishable from those of mucus‡." Dr. MANDL's opinion, that these objects are identical, has been already mentioned. If then pus and mucus-globules are "identical," or "not distinguishable," their source is not likely to be very different: and pus-globules we have just seen to be derived from corpuscles of the blood. I would also compare figs. 68 to 71. (mucus), with figs. 63 and 64. (pus) in this memoir, as well as with fig. 23. (blood-corpuscles) in my last paper§. See also figs. 72 and 73. in the present communication. The blackish mucus from which these last were taken, presented, not merely corpuscles having the same appearance as altered blood-corpuscles, but such as resembled young corpuscles of the blood themselves, of the characteristic colour, and in an unaltered state.

108. Whether the highly refracting globules in the cells fig. 103. were those of fat, I do not know; but their appearance suggested the idea that this was the case; and the cells containing these globules were certainly altered corpuscles of the blood. For a particular description of these cells, I refer to the explanation of the figures. It may, however, be added here, that each of the globules resembling fat seemed to occupy the *central* part of what had previously been discs.

109. There are but few of the figures accompanying this memoir, which do not directly or indirectly confirm the observations recorded in my last. Among those affording direct confirmation of the same, may be mentioned figs. 75, 76, 77, 78, 79, 80, 81, 82, 83, 84. Some of the blood-corpuscles in these figures exhibit discs, existing both within and around the nucleus of the blood-corpuscle while in circulation. Others (figs. 67 *a*. 76. 78.) seem to represent conditions of the "lymph-globules," or "corpuscles of the second form" of authors.

110. The only views I am acquainted with, regarding the place which blood-corpuscles should be considered to occupy as "cells," are those of SCHWANN, and VALENTIN. The former considers this corpuscle as a nucleated cell; while the latter

† *L. c.*, par. 48. fig. 20.

‡ *L. c.*, p. 80.

§ On the Corpuscles of the Blood, Part II. *l. c.*, p. 201.

maintains that it is a nucleus,—the object usually termed the nucleus, being really the nucleolus. From my own observations, it appears that, paradoxical as it may seem, both these views admit of being established. The fact is, that at an early period the corpuscle of the blood is a mere disc, having a cavity or depression representing the "nucleolus." At this period the corpuscle may be called a nucleus; though it does not seem desirable to use this term, before the formation of the cell. Subsequently, the outer portion of the corpuscle or disc becomes transformed into minuter discs, which coalesce to form a membrane; and the inner portion is now the nucleus, the entire corpuscle being a cell.

111. At α of fig. 144. is a corpuscle resembling a young corpuscle of the blood, in which the central part was red, and the outer part pale. At α, fig. 95, is a blood-corpuscle, the discs in the altered nucleus of which, generally speaking, had a deeper red, the nearer they were to the centre of the nucleus. These may serve as examples, showing that there is a continual re-appearance of red colouring matter, and that it comes into view around the orifice in the nucleus.

Epithelium-tables, cells, and cylinders compared with Corpuscles of the Blood.

112. On examining the tail in a great number of Tadpoles,—the larva of the large Toad found in Jersey,—these Tadpoles measuring from $4'''$ to $6'''$ (Paris lines) in length, I found the central part of the epithelium-tables to present an appearance so varied, that it would have been vain to expect that, by figuring those of any one part, an idea could be given of their general appearance. Nor can I hope to have yet done so; but it seemed desirable to sketch a few of the states noticed, without regarding the relations of the tables to one another, and without confining myself, in the delineation, to the same individual.

113. Before referring more particularly to these, I will just express my surprise at its having been possible for any one to examine the tail of a single minute Tadpole, without recognizing in its epithelium, corpuscles having the same appearance as corpuscles of the blood. And I see no way of reconciling the acuteness of observers with the absence of this recognition, except by supposing the Tadpoles examined to have attained a far greater size than those examined by myself—measuring chiefly from $4'''$ to $5'''$. In those of the lengths now mentioned, I find it impossible to discern an essential difference in appearance between the objects entering into the formation of the edge of the tail, and blood-corpuscles circulating in this larva (par. 196.). The comparison is very easy, if made after the corpuscles are at rest within their vessels. It frequently happens too, that the placing of a piece of glass or mica upon the tail, lacerates the edge, and separates epithelium-tables from it (fig. 86. α, β.); when it is seen that these tables, in their form, size, colour, and internal state, have the same appearance as the blood-corpuscles which were circulating just before, in the same field of view.

114. The nucleus in some of the epithelium-tables fig. 86, bore a curious resem-

blance to certain states of the germinal vesicle figured in one of my former papers†. Other conditions of the nucleus in some of the same epithelium-tables, equally resemble the appearance of the discs or incipient cells succeeding that vesicle in the ovum‡: and in fig. 88. we have remarkable evidence of the appearances presented by the contents of the ovum, and those of the epithelium-tables, being both referable to the operation of the same process. This remark applies equally to blood-corpuscles, apparently destined to enter into the formation of the epithelium, in fig. 95.

115. The resemblance between corpuscles of the epithelium, and those of the blood, is not confined to the part we have been considering. All the epithelium-cells which have fallen under my notice present it more or less decidedly. Even those collected from the surface of the tongue (fig. 92.), while they exhibit the greatest irregularity in size and form, and considerable variety in the appearance of the interior, present the same sort of discs, and the same division into minuter discs; many of them being also tinged with the same red colouring matter as is perpetuated or reappears in the discs of other parts, more closely resembling corpuscles of the blood. The nucleus also of the epithelium-cell from the tongue, is composed of discs; and I have seen it remarkably tinged with red. Among the cells from a furred tongue, there were seen heaps of discs of a blood-red colour. The membrane of the epithelium-cell—where a cell exists, as in fig. 92.—is obviously formed by the same coalescence of discs, as that which we shall find to give origin to other membranes, —for instance, to the membrane of the ovisac, figs. 170, 171, 172, *h*.

116. The formation of what have been denominated epithelium-cylinders, I have not had the opportunity of particularly following; but may offer a few incidental observations. In fig. 94 *a*. is the outline of a cell which was red throughout, and filled with young epithelium-cells. The latter presented traces of division into objects still more minute; and this division at one part had really taken place. Traces of division were observed also in the objects figs. 95. 99. and 100; the blood-red colour of many of which, passed at one extremity nearly into black. Should these have been, as I believe they were, incipient epithelium-cylinders, the observation, so far from having realized the following conjecture of Professor VALENTIN, will stand in direct opposition to it. "It appears," says he, "judging at least from the nuclei, as though cilia-cylinders arose through the coalescence of two adjacent cells, and the disappearance of the partitions. There are often seen, at least, in one and the same cylinder, two nuclei, one on the other, or in part covering one another§." Were not the two nuclei, seen by VALENTIN, produced—like those in the figures, last referred to—by division of a previously single nucleus? If so, it would seem that cilia-cylinders arise, not by coalescence, but by division, like some of the Vorticellæ; which they resemble also in the position of the cilia.

† Compare with *c*, figs. 159, 160, 162, 169, in my Third Series on Embryology. Philosophical Transactions, 1840, Part II. ‡ Compare with fig. 195 in my Third Series on Embryology, *l. c.*

§ MÜLLER's Archiv, 1840, Heft II. p. 205. *Note.*

The Elements of the Pigmentum nigrum, and those of the Ciliary Processes, compared with Corpuscles of the Blood.

117. The general appearance of black pigment, as seen, in a formed state, in the choroid coat of the eye, is well known. And that variety of this substance met with in the tail of the Tadpole, has been accurately represented by Professor SCHWANN, in a certain stage†. As to the mode of origin, however, of this substance, in either of the localities just mentioned, I am not aware that we possess any published information: a remark equally applicable to the blackish substance found in mucus from the air-passages. Perhaps the following observations, therefore, may be useful.

118. In Tadpoles of $4\frac{1}{2}'''$ to $5'''$, I find the blood-corpuscles to contain, situated on the nucleus, certain red globules (fig. 75. α.), appearing to transform themselves into discs (β) of the same red colour. Now in the epithelium-tables above mentioned, as so much resembling the blood-corpuscle, the peripheral part is composed of red discs. The red discs of several tables are necessarily in contact. They coalesce, and present the appearance delineated in fig. 89. Each line of discs in this figure, it will be seen, is made up of those derived from two adjacent tables. These discs, quite red in the figure now referred to, subsequently divide into extremely minute, blackish objects, which adhere together, and form partitions between the central portions of the tables. In a state more advanced, it is not easy to discern this partition-like appearance, nor to connect the very irregular forms into which the partitions are distorted, with their original figures of six sides. At γ in the figure last mentioned, is a stage more advanced than that at β; but the objects were still seen to be composed of discs. They also presented a trace of the partition-like appearance, and were still red. In fig. 91, are stages of these objects yet more advanced (but from another part), and apparently corresponding to those figured by SCHWANN from the tail of the Tadpole. In the latter stages they are known under the name of pigment ramifications,—of which I think the observations now detailed, may assist to show the mode of origin.

119. The large object connected with the pigment ramifications (figs. 90, 91.) appears to be a centre for the reproduction of epithelium-tables; for those in fig. 88. are corresponding objects, in which this reproduction is very obvious—the pellucid, germinal vesicle-like nucleus on one side of the object figs. 90 and 91, being, more particularly, the centre from which the reproduction proceeds.

120. But one of the figures just referred to (fig. 91.) was taken from the pigment of the eye; which seems to be produced in a manner precisely such as that just described, as giving origin to similar appearances in the tail. This will be obvious, I think, if the object on the right hand in fig. 93. (eye) be compared with fig. 89. (tail). And each of these presents a centre for the origin of new substance (the peripheral discs), like the centres just referred to. (Fig. 93. will be found fully described in the

† *L. c.*, Tab. II. figs. 8 and 9.

explanation of the Plates; with the mode of origin of the pigment in the choroid. The discs of the bright red δ and ε, in this figure, undergo division, and are given off, to enter into the formation of the darker and blackish ζ. It appears that what is seen of ζ in the figure, had been formed by portions previously given off in this manner. So that here, in the pigment of the eye also, we find centres (δ. ε.) for the origin of new substance). It is important to add, that all the objects now mentioned, had the appearance of altered corpuscles of the blood.

121. The black substance found in mucus from the air-passages, arises in a manner somewhat similar; presenting itself at the outer part of corpuscles quite as red as corpuscles of the blood. See fig. 72.

122. Portions of ciliary processes, as seen in the eye of a Tadpole of $5\frac{1}{2}'''$, are represented in fig. 101. They are in outline only; for the parts composing them, from their colour, form, size, and general appearance, so much resembled slightly altered blood-corpuscles, that it did not appear requisite to make elaborate drawings of them. It is, besides, extremely easy to repeat, and therefore to confirm, this observation, or show it to have been erroneous.

The Primitive Discs exhibit an inherent contractile power.

123. This was manifested by the elongated discs of the epithelium-cylinder fig. 98. α, β; and by the isolated disc, two appearances of which are represented at δ in the same figure. This isolated disc was observed for a considerable time to change its form and place. Some of the discs composing the paler part of the cylinder α, β, were, for about twenty minutes, seen to be in motion; and there was thus produced a very slow revolution of the entire object on its axis, in the direction of the arrow. (In connection with this subject, it may be mentioned, that the object in fig. 139 which is more finished in delineation than the rest, and constituted the centre of the forming crystalline, on being viewed repeatedly for a considerable time, was found to vary in its appearance; a phenomenon which seemed to arise from the discs changing their position. This object, as will be found stated elsewhere (par. 181.), had all the redness of a corpuscle of the blood.)

The Nuclei of Blood-corpuscles furnish themselves with Cilia, revolve, and perform Locomotion.

124. Ciliated corpuscles are seen in figs. 105 and 104. Those in the first of these two figures were observed in the blood of a rabbit, taken from vessels in the immediate neighbourhood of a Graafian vesicle, which, from its size and vascularity, had evidently been destined to expel an ovum. The corpuscles in the latter figure were noticed in a substance from the eye of a fœtal calf of $5\frac{1}{4}$ inches, more particularly described in the explanation of the Plates. The rabbit had been killed eighteen

hours; and two days had elapsed after the fœtal calf had been taken from the body of its mother, before I made the observation now recorded.

125. The corpuscles in question had thrown off their membrane (if they ever had one,—for they seemed altered *young* corpuscles, or mere discs). It was therefore the nucleus of the corpuscle, which had become endowed with cilia; but this nucleus was quite red. The cilia presented the appearance of acuminated processes from the discs composing the corpuscles. It seemed to be by means of these, that the corpuscles in some instances slowly revolved, and in others changed their place. One of the corpuscles (β. fig. 104.) appeared to shoot forth a process, the cilium, which then as quickly disappeared, as if drawn in. Cilia could not be discerned on the corpuscle β, fig. 105. Yet one of its discs seemed to be in (incipient?) motion. We have elsewhere seen, however, that discs exhibit motion independently of cilia (par. 123.).

126. Besides the above, I have observed young blood-corpuscles (fig. 106.) performing constant and considerable locomotion; which, in some instances, was by no means slow. The motion of some resembled that known under the name of molecular, and others of these moving blood-corpuscles were so minute as to be comparable to molecules enlarged (pars. 198, 199.).

127. In a former communication† I described some most curious motions, or rather changes in form, observed under particular circumstances in corpuscles of the blood, and, in a note, added to that communication, stated that I had been induced to believe that those changes in form were referable to contiguous cilia. I ought now to state that subsequent observation enables me to say that these changes in form arise from some inherent power, distinct from the motions occasioned by cilia.

Molecular Motions discernible within Corpuscles of the Blood.

128. Minute red points around the nucleus within the blood-corpuscle, have been already mentioned, as observed in the Tadpole (fig. 75. α). Such points or globules exhibited molecular motions. The discs, formed apparently out of such objects, as in the corpuscle β of the same figure, did not exhibit motions, but were pressed together into polyhedral forms. In fig. 124. α, and fig. 123, globules such as those just mentioned appeared to be undergoing division. They at least presented the appearance of a rose, the same as that so often seen elsewhere. Molecular motions were exhibited by the globules contained within the cell fig. 102. I refer to the explanation of the Plates for an account of the circumstances under which these motions were observed; and have only to add, that the colour of the entire cell was precisely the same as that of the blood-corpuscles along with which it was observed.

129. It is known, through the researches of Henle, that the rete Malpighii consists of round cells furnished with a nucleus; which cells this observer, and subse-

† On the Corpuscles of the Blood, Phil. Trans., 1840, Part II. pars. 12—18.

quently SCHWANN, succeeded in tracing into the cells of the epidermis. The latter supposes that a cell-formation takes place immediately on the surface of the cutis†. But here I cannot help referring to the process of division we have seen reproducing the epithelium-tables of the Tadpole; a process which it seems probable, from other of my observations, is universal, including, therefore, even the epidermis.

The Elements of Blood-vessels compared with Corpuscles of the Blood.

130. Capillaries in the course of formation out of corpuscles having the same appearance as corpuscles of the blood, are represented in fig. 107. These corpuscles, still red (α), apply themselves together so as to form an object resembling a necklace composed of elliptical beads; and having coalesced, and become pale (β), and the membranous partitions (at the extremities of the beads) having disappeared, they constitute a tube. The membrane of this tube is formed in the same manner as, according to my observations, the membrane of the ovisac, the chorion, and other membranes;—namely, by the coalescence of discs, as at α in the upper part of the above figure. At certain parts, the corpuscles apply themselves in such a manner as to form a branched vessel. An example of this is to be found in the figure; which also shows the corpuscles, coalescing in this instance for the formation of capillaries, to have been of very minute size. They had the same appearance as *young* corpuscles of the blood. At δ is a round space. This space was colourless, and brilliantly pellucid. And I am by no means sure that it was not an orifice left in the membrane of the tube (pars. 152, 162, 178.).

131. If the vessels have their origin in corpuscles of the blood, it is scarcely needful to inquire from what source they derive the materials for their thickening also, and for the formation of the several coats of which they become composed. It may be mentioned, that some of the pale discs in fig. 142.—evidently derived from corpuscles of the blood—seemed, by coalescence, to be entering into the formation of the membrane of the vessel. But here also, as appears to be the case in every other tissue, the original corpuscles (fig. 107.) no doubt contain within themselves the means of perpetuation.

132. While the investigations forming the subject of this memoir were in progress, I received a letter from Dr. W. B. CARPENTER, of which the following is an extract. It requires no comment, except the expression of my concurrence, as furnished by the foregoing observations:—"Having been just lecturing on the blood and the process by which it becomes organized, I think it well to mention to you some views which have occurred to my mind in reference to your observations on the conversion of blood-corpuscles into tissue‡. When *lymph* is thrown out upon an inflamed membrane, and is in process of becoming organized, it has been long known that the

† SCHWANN, *l. c.*, p. 86.

‡ Dr. CARPENTER here refers to my first paper on the Corpuscles of the Blood, Philosophical Transactions, 1840, Part II.

membrane beneath is usually much softened, and that its vessels seem to have a tendency to prolong themselves into lymph. Some have asserted that vessels and *red blood originate* in the lymph; but this has always appeared to me very doubtful. Now if your views be correct, I should see no difficulty in understanding that the vessels of the subjacent membrane prolong themselves, not by any *vis a tergo* (as some have supposed), but by the development of the blood-corpuscles stagnated in them first into cells and then into tubes, which convey blood into the coagulum; and this blood again contains the elements of a further ramification of capillaries, which will go on being formed in this manner, until a complete network is produced. It may be objected to this view, that coagulated *blood* ought to become organized more readily than *lymph*—which experience shows that it does not. But it may be replied that blood *mechanically* effused is in a very different state of vitality from the coagulable lymph or liquor sanguinis poured out on the surface of an inflamed membrane; and that these changes of the corpuscles do not take place in those of the clot or coagulum itself, but in those of the vessels in the living tissue beneath. It is very interesting to find a theory harmonizing with previous observations, which is I believe the case in this instance. Rows of corpuscles, proceeding from the red points of the subjacent membrane, have been seen in coagulable lymph; but their *import* was not known as I believe it now may be†."

The Elements of Cellular Tissue compared with Corpuscles of the Blood.

133. There is no tissue the elements of which resemble altered blood-corpuscles more than those of the cellular. And there is certainly no tissue which it is of more importance to trace back to such objects, than this; because of its presence almost everywhere in the body, either as cellular tissue, or in the more condensed state of the parts, into the formation of which it enters. This remark is of course applicable in a pathological, as well as in a physiological point of view.

134. On reference to figs. 109. 111. 112, it will be seen that the first changes visible in the formation of this tissue, are in no small degree like those presented by the incipient pus-globule (par. 101.). And this similarity we shall meet with again and again, as we examine the elements of other tissues. The corpuscle at α, fig. 109, presenting the same appearance as a slightly altered corpuscle of the blood, has one large orifice; in those at β there are two or more orifices of smaller size; and subsequently a number of bright points come into view. These points seem to be the cavities or depressions in as many discs, between which discs red colouring matter still lies, and conceals their margins. The bright points, therefore, *seem* as if contained in a mass of red colouring matter. The form of the corpuscle sometimes undergoes a considerable change, before the margins of the discs are distinctly seen, as in fig. 109. γ; where it presented the appearance of an elongated, flattened mass. The discs, however, are soon distinct (fig. 112. β, fig. 111.); and the explanation of

† Dated Kingsdown, Bristol, Feb. 8, 1841.

the Plates will show that here, as in figures of the elements of other tissues, the transition from a corpuscle having the same appearance as a corpuscle of the blood, into a mass of discs, was quite unequivocal, in colour and in form, as well as in the gradual appearance of the discs. It is important to remark, that the mass of discs presents, not the entire corpuscle, but its nucleus enlarged.

135. This mass, already elliptical (fig. 109. γ), becomes pointed, and usually at both ends (figs. 110. 111, fig. 112. γ). The pointed extremity is then elongated into a filament (see the same figures); and apparently by the following means. The comparatively large discs into which the corpuscle has divided, undergo division and subdivision themselves, until discs are produced of extreme minuteness. These coalesce to form the filament; which has in its interior the means of perpetuation, through discs, into threads still finer. (This seems to be the general mode of production and thickening of membranes and fibres.) The elongation of the mass of discs into filaments, takes place sometimes in more than two directions. The whole mass of discs does not at once pass into filaments; but a part, enlarging, becomes a special centre, apparently for the origin of new substance (fig. 112. γ); as we saw in the epithelium, and pigmentum nigrum (pars. 119, 120.). But every disc, large enough to be discerned and traced, seems to exhibit a reproducing property.

136. The figures present examples of the elements of cellular tissue thus formed, from various parts, and, among others, from the thigh (fig. 109.), the neck (fig. 111.), and the axilla (figs. 112, 113.); as well as a drawing of this tissue, entering into the formation of the sheath of the spinal chord (fig. 116.). The fibres of cellular tissue forming this sheath seemed to be interlaced.

The Elements of the Corpus luteum derived from Corpuscles of the Blood.

137. In a former memoir†, I described the Graafian vesicle as formed by the addition of a covering to the previously existing ovisac. The covering was stated to consist of a kind of dense cellular tissue, susceptible of becoming highly vascular. In a later communication, I came to the conclusion, that the covering of the ovisac becomes the corpus luteum‡.

138. Confirming these observations, I have now to make the following addition. On examining the vessels entering into the formation of the covering of the ovisac, and rendering it highly vascular, in a rabbit killed three hours post coitum, I found them filled with blood-corpuscles in an altered state. The central part was greatly enlarged, colourless, and brilliantly pellucid; and the contour was lost by the slightest pressure, so that the red colouring matter of adjacent corpuscles had the appearance of being blended into a mass, filling up the interstices between their round, colourless, and brilliant centres. This condition of the blood-corpuscles within the vessels, too much resembled that which I had met with in other parts, formed out of corpuscles

† Researches in Embryology: First Series. Philosophical Transactions, 1838, Part II. par. 24.

‡ Second Series. Philosophical Transactions, 1839, Part II. par. 156.

having the same appearance as corpuscles of the blood, not to induce the belief, that it is the blood-corpuscles entering into the formation of the covering of the ovisac, which form the corpus luteum.

139. As long since as in the autumn of 1838, my friend Dr. HODGKIN mentioned to me a view entertained by him, that the blood sent to the enlarged Graafian vesicle, becomes the corpus luteum. This requires from me no other comment than that afforded by the observation now recorded.

The Elements of Cartilage and other Tissues compared with Corpuscles of the Blood.

140. The early stages in the formation of cartilage, which happen to have fallen under my notice, were observed in the foundation of a bone in one of the lower extremities of a fœtal chick, on the tenth day of incubation (figs. 119, 120.); in the foundation of a spinal vertebra from the same chick (fig. 122.); in that of one of the cranial vertebræ from a Tadpole of $5'''$ (fig. 117.); in the foundation of the orbit in another Tadpole of the same size (fig. 121.),—this cartilage having been seen in a different state in a Tadpole of $6'''$ (fig. 118.); and also in an incipient spinal vertebra from one of these larvæ. In these observations, a transition out of corpuscles having the same appearance as corpuscles of the blood, was either directly witnessed, or to be inferred. Such corpuscles, generally speaking, are not represented in the figures, because the cartilage was too far advanced. Yet in fig. 117, on the left side, there may be seen two remarkable corpuscles of this kind. The eye becomes so accustomed to the altered nucleus of the corpuscle, having the same appearance as the corpuscle of the blood, that it is scarcely requisite to see that corpuscle in an entire state. In these observations, however, there was not wanting the characteristic red. In fig. 119, for instance, this colour was recognizable after the nuclei had begun to arrange themselves into fibres; in fig. 122. the young corpuscles α, situated in the incipient cartilage of a vertebra, were blood-red; in fig. 117, on the left side, as already mentioned, is the outline of two elliptical corpuscles having the same colour and general appearance as the blood-corpuscles circulating in the vessels of the same larva (the Tadpole); and the red colour was noticed also in the objects of fig. 121.

141. It may here be remarked, that the corpuscles which, in the incipient cartilage fig. 117, had the same appearance as the blood-corpuscles of the animal, were situated in the most superficial part, as though *added* to corpuscles previously there. This was the case, also, with the young and red corpuscles α in fig. 122. And we shall hereafter find the same superficial situation to be occupied by the newest corpuscles entering into the formation of the optic nerve (par. 151.).

142. In examining the foundation of cartilage, the observer is struck with the regularity of distance between the nuclei of the corpuscles; this being referable, apparently, to the presence originally of the entire corpuscles (fig. 117.), the outer part of which afterwards disappears (fig. 121.); and a dense mass is formed, by continual additions from the nuclei, as centres for the origin of new substance. It seems to

have been on cartilage in this more advanced state, that observations heretofore have been principally made. And the figures given by SCHWANN of cartilage†, show, I think, the continued existence of centres of this kind.

143. A suggestion offered in one of my former memoirs‡, seems to have been realized by the observations recorded in this paper; for the elements of cartilage are certainly the seat of changes essentially the same as those we formerly witnessed in the cells succeeding the germinal vesicle in the ovum.

144. We also find that cartilage exhibits centres, such as those we have seen to exist in the epithelium (par. 119.),—in the black pigment of the eye (par. 120.),—in cellular tissue (par. 135.),—as are to be recognized, I think, in the "Ganglion-globules,"—and the most remarkable of which centres is the ovum. But in these special centres there is to be witnessed no other than the same process, as that which operates in the nucleus of every cell.

145. Fig. 116½. represents the outline of very large cells, filled with other cells. The large cells had the appearance of altered blood-corpuscles; the colour being also pale red. The nuclei were for the most part blood-red, and not distinguishable from young corpuscles of the blood (fig. 106.), lying near them. From the great length of the object formed by the large cells just mentioned, and from its general appearance, I am disposed to regard it as the foundation of the cartilage destined to form a bone; but the object, though consisting of large cells, was so minute, that an opinion here must be cautiously expressed.

146. The extremity of the incipient beak, as well as that of a claw, from a fœtal duck, on the 13th day of incubation, were found to be in a state of the same kind as the forming cartilage in fig. 119; and there was observed a transition out of corpuscles having the same appearance as corpuscles of the blood.

147. A like origin has seemed to be presented by the elements of feathers in the chick: but my observations here have been but few.

148. Though rather out of place, it may be mentioned, that in the Tadpole which yielded the drawing fig. 121, I saw what appeared to be the foundation of a ligament, also having an origin in corpuscles which presented the same appearance as corpuscles of the blood, and seemed to be arranging themselves into a fibre.

The Elements of Nervous Tissue compared with Corpuscles of the Blood.

149. The optic nerve in the Tadpole of 4½‴ to 5‴, seen as it is entering the eyeball, is very easily found, and there is not much danger of any other object being mistaken for it. My observations on the optic nerve, at this early period, have been very numerous, and, it may be added, highly satisfactory.

† *L. c.*, Tab. I. figs. 5–9. Tab. III. figs. 1, 2. ‡ Researches in Embryology: Third Series, *l. c.*, par. 393.

150. Figs. 123, 124 and 125, present portions of this nerve in a more or less incipient state. The objects represented, chiefly in outline, in fig. 123, observed at a part of the nerve near its entrance into the eye-ball, were all corpuscles having the same appearance essentially as corpuscles circulating in the blood. I refer for a particular description of these to the explanation of the Plates. The nerve did not present any fibres; and so incipient was it, that at the part represented in the figure, the corpuscles had their original elliptical form. In another instance, where the nerve was rather more advanced, the globules surrounding the nucleus (see the corpuscle more finished in delineation than the rest in fig. 123.), had very much disappeared, and the corpuscles were pressed into polyhedral forms.

151. In a former page, I mentioned that the foundation of cartilage had presented an appearance, suggesting, from the more advanced state of the interior, that corpuscles had been *added* at the outer part. Such an appearance is even more remarkable in the optic nerve, as shown in fig. 124; all the objects in which (presenting, it will be seen, very different states) were observed in the same nerve. I have stated that the corpuscles in fig. 123. had *essentially* the same appearance as that of corpuscles of the blood. Respecting those at α, in fig. 124, it may be said that their appearance was *precisely* such as that of corpuscles circulating in the blood of the same larva. Yet the interior of the nerve in this instance was in a more forward state than that of the one before referred to (fig. 123.); the other objects in fig. 124. having been composed of discs (some of them forming necklace-like objects, or incipient fibres), derived from the nuclei of corpuscles, such as those just mentioned (α). These discs were all red; the colour being paler in the more advanced. (See the figure and the minute explanation of it.)

152. Portions of this nerve, in a more advanced state, are seen in fig. 125. The discs at α, into which the nuclei of the corpuscles had divided, were arranging themselves in something like lines. They presented minuter discs in their interior, as in the part represented less in outline than the rest. The tube β, yet more advanced, was forming out of discs, which were coalescing at its periphery. These discs, corresponding apparently to the minutest of those at α, again, presented other discs in their interior. Pellucid points, apparently orifices, were seen here and there. They seemed to communicate with the exterior of the tube (pars. 130, 162, 178.). These pellucid points correspond to the depressions in the original discs. As in muscle, there are doubtless in the interior of an object such as β, the elements of new substance,—the essential portion of the nerve.

153. In these researches, a considerable share of my attention has been devoted to the elements of the retina; which afforded ample proof of their origin in corpuscles, having the same appearance as corpuscles of the blood. Some of these elements are represented in figs. 126 to 131; and it will be seen that they are of the same character, whether taken from the fœtal Calf, fig. 130, or from the Tadpole, fig. 131; consisting, in both, of round, flattish masses of discs.

154. Here also, corpuscles having the same appearance as young corpuscles of the blood, become orange-shaped, present two or more bright points with red colouring matter between them (see the figures); and, as the colouring matter disappears, admit of being traced into the masses of discs just mentioned; these being the altered nuclei of the corpuscles in question. We thus find in the elements of the retina, as well as in those of cellular tissue (par. 134.), the same appearances as those presented in the formation of pus-globules out of corpuscles of the blood.

155. After the corpuscle, having the same appearance as corpuscles of the blood, has become a mass of discs, the discs may undergo division and subdivision to an inconceivable extent, and to which we can set no bounds, as regards either the number or the minuteness of the resulting objects. It will be observed, from fig. 130, that cells are formed; their membranes arising—as elsewhere, according to my observations—from the coalescence of minute discs. These cells will be found minutely described in the explanation separately given. It is not my purpose in this memoir to follow their subsequent progress.

156. I have frequently met with the rudiment of the spinal chord,—sometimes in fragments, sometimes almost entire,—as it exists in the tail of the Tadpole; this larva measuring $5'''$ or $5\frac{1}{2}'''$. Its newest part I found composed entirely of corpuscles having essentially the same appearance as corpuscles of the blood, and being in a state resembling (but somewhat more advanced than) that which they presented in the optic nerve fig. 124 α, and also arranged in lines. In fig. 132. is an outline of some of the corpuscles which I observed constituting this structure in a Tadpole of $5\frac{1}{2}'''$. The spinal chord has uniformly appeared to be less advanced than the cellular tissue which seemed to be entering into the formation of its sheath (par. 136.).

157. Corpuscles from the cortical substance of the brain in a fœtal Calf of $5\frac{1}{4}$ inches, are seen in fig. 133: and fig. 134. represents some of those observed in the medullary part of this organ, in the same subject.

158. Objects such as those in the first of these two figures, were observed in large number; and often seen to be flattish in their form. They were all more or less red,—some blood-red; all were either discs, or composed of discs,—being either themselves corpuscles, having the same appearance as corpuscles of the blood, or immediately derived from such corpuscles. Here, as often observed in other parts in the course of formation, the corpuscles were found to be of a minute size; being apparently young corpuscles. They presented the same gradual transition into the elements of the brain, as we have seen in other parts, regarding a change in form, colour, and division into discs; besides the previous appearance of an orifice (β), in the situation of the depression presented by the corpuscle when discoid in its form. The gradual formation of a membrane too, by coalescence of the outer discs, was witnessed here (η). These details will be found more fully given in the explanation of the Plates. And perhaps there is no figure more instructive, as regards the changes

presented by the corpuscle or disc,—its passage into *layers* of discs,—the comparative age of these,—the reappearance of red colouring matter,—and the *secondary* nature of the "cell," than the figure now before us—fig. 133. To the description of this figure, in connection with that of fig. 134, I particularly refer.

159. Very much the same general remarks apply also to the elements of the medullary portion of the brain (fig. 134.).

The Elements of Muscular Tissue compared with Corpuscles of the Blood.

160. Some of the earliest appearances presented by muscle, in its formation out of blood-corpuscles, were given in one of my former communications to the Society†. The muscles then examined, being involuntary, did not afford so interesting a field for observation, as those the development of which has since had my attention,—the voluntary muscles; nor did I then prosecute the investigation farther than as opportunity was incidentally afforded. Nevertheless, it will be seen that the facts I have now to mention, accord with those stated in that memoir.

161. Corpuscles more or less blood-red, and having the appearance of young blood-corpuscles, apply themselves to one another in the manner represented in fig. 135, and also in the memoir just referred to; by which a necklace-like object is produced. These corpuscles are cells, which I have found filled with discs (β). The appearance of these discs, together with that of the nucleus and nucleolus, resembled in a remarkable manner the corresponding parts in certain states of the germinal vesicle and germinal spot‡. In no instance have I more clearly seen the nature of the so-called "nucleolus" of authors; and that at this part there exists an orifice, communicating with the exterior of the cell (fig. 135. β). By degrees, the appearance of a cylinder is produced (fig. 136.), which becomes more perfect, as the partitions between the cells, just mentioned, disappear—fig. 137. In this figure, nuclei are still seen, having a parietal situation; these being, as SCHWANN supposed, the nuclei of the original cells (fig. 135.). It must not, however, be supposed that no change takes place in the nuclei; or that the nuclei seen in such a stage as that in fig. 135, are *identical* with those presented in the later state, fig. 137. It appears to me that the nuclei in the later state, merely occupy the same place as those in the earlier. For here, in the muscle-cylinder,—or as SCHWANN has termed it, the "secondary" cell,—the same process is in operation as, according to my observations, is seen everywhere else in what have been called the primitive cells; namely, a continual change in the nucleus. A part continually passes off in the form of discs, which are contained within the cylinder; while a fresh supply of discs is continually coming into view around an orifice, connecting apparently the interior and exterior of the muscle-cylinder, or "secondary cell." This *orifice*, however, appears to be identical with that existing in the original cells, fig. 135.

† On the Corpuscles of the Blood, Philosophical Transactions, 1840, Part II. p. 595.

‡ Compare β of fig. 135, with *c* of fig. 160, in my Third Series on Embryology, *l. c.*

162. It is to VALENTIN and SCHWANN that we are indebted for the observation, that the muscle-cylinder is formed of nucleated cells. But the other facts now mentioned†, I believe are new; namely, the more or less blood-red colour of the original cells (fig. 135.), the presence of discs in their interior, the derivation of these discs from the nucleus, the existence of an orifice at a certain part of the nucleus, and a continuation of these appearances in the muscle-cylinder, or "secondary‡" cell. We may hereafter see reason for thinking it not unimportant, that the contents of the "primitive" cell, and those of the "secondary" cylinder, should have their origin in the nucleus; as well as to connect this fact with the existence of the orifice in question. The muscle-cylinder thus contains centres such as we have seen elsewhere‡ (pars. 130, 152, 178.).

163. The discs filling the muscle-cylinder, are the seat of elaborate changes; as is to be inferred, I think, from the very remarkable appearances they afterwards present. These appearances will form the subject of a future memoir, which it is my intention to offer to the Society; for I feel it incumbent upon me, because due to the Society, to show that certain conjectures in one of my former papers, printed in the Philosophical Transactions, have been fully realized.

The Elements of the Crystalline Lens compared with Corpuscles of the Blood.

164. If there is any structure which it would at first sight seem impossible to trace back to corpuscles having the same appearance as corpuscles of the blood, that structure is surely the crystalline: and none but the most conclusive evidence will suffice, to prove that this admits of being done. Whether the observations I have to offer are of this character, the future must determine. I can only say that they were repeatedly confirmed.

165. I am enabled to verify Professor SCHWANN's description of the pale cells of the crystalline; except as regards the nucleus, nucleolus, and contents of the cell. (But in these respects my views are peculiar, with reference to "cells" in general: a remark applying also to the mode of formation of the membrane of the "cell," to the manner in which cells are reproduced, and to the secondary nature of the "cell" (par. 173.)). My observations also corroborate his view, that the foundation of the fibres of the lens consists of cells. But they do not enable me to adopt the

† Though merely an extension of those I formerly communicated with reference to the ovum.

‡ In later stages there exist other centres for the origin of new substance within the cylinder; and chiefly in its central part. Some of these have been figured by SCHWANN (*l. c.*, Tab. IV. figs. 1, 2.), and especially by BOWMAN (Philosophical Transactions, 1840, Part II. Pl. XVIII.), who denominates them the "corpuscles of the primitive fasciculi." I recommend particular attention to the observations of the last-named author, on these corpuscles (*l. c.*, pp. 484, 485.). He considers it "not impossible that" *** "there may be during development and subsequently, a farther and successive deposit of corpuscles, from which both growth and nutrition may take their source" (*l. c.*, p. 485.). In this I concur; and may add, that the process we saw in operation in the germinal spot, and, as above described, in muscle,—is no doubt applicable to each of the corpuscles observed by BOWMAN; which in my opinion are continually reproduced by division.

opinion of this eminent observer, that the fibres are *elongated* cells. The mode in which the fibres seem to me to form out of cells, will be hereafter mentioned. The first, and more important question is, what is the material furnishing the cells, and therefore the fibres of the lens? It is here needful to make a few preliminary remarks.

166. Slices cut from the surface of the lens in the fœtal Calf and Sheep, have presented to me in the microscope, not only red blood, but young blood-corpuscles, as well as the parent-corpuscles from which they were escaping. Seldom have I had so favourable an opportunity for observing the manner in which the blood-corpuscle is perpetuated (fig. 141. δ δ), and for making the observations I have now to mention, —that the young blood-corpuscle has a peculiarly bright colour, and—though in Mammalia—an elliptical form. The young corpuscle soon becomes round, though at first it continues flat; the latter no doubt answering an important end connected with its motion in the vessels.

167. Fig. 141. affords a proof that the diameter of the corpuscles usually seen in circulation, is no criterion by which to judge whether red blood can make its way into parts generally considered colourless. For, at α, a portion of vessel is filled with corpuscles, having a diameter not much more than half of that usually ascribed to them: the fact being that, besides the minuteness of the objects into which blood-corpuscles may divide, the form of the corpuscles is susceptible of every change; and minute indeed must be the orifice they could not be made to enter, so attenuated is the shape they sometimes assume. It may be also added, that I have observed a capillary forming, the diameter of which measured only $\frac{1}{700}'''$, which indeed was about the size of some of those in fig. 141: and I have seen objects having precisely the appearance of blood-corpuscles, of less than $\frac{1}{1000}'''$. Mere points too, are found, having the red colour of the blood, and we have already seen that minute objects exhibiting molecular motions, may be observed within corpuscles of the blood (par. 128.); as well as that young corpuscles of the blood are met with, exhibiting motions comparable to that called "molecular," and so minute indeed as to have the appearance of "molecules" enlarged (par. 126.).

168. Corpuscles having the same appearance as young blood-corpuscles, are also seen within tubes—fig. 144. And this figure shows that, while the red colouring matter was still present in some, it had disappeared in others,—the latter being represented in outline only.—Other states of the corpuscles are observed, also within tubes, as in fig. 149. They here exhibited the same division into discs which we have found to take place elsewhere: and while some of the corpuscles undergoing this division were blood-red, others were becoming pale. A farther change is met with: the masses of discs, derived from such corpuscles, seem to be arranging themselves into lines, as if to form fibres (fig. 150.).

169. I have seen red capillary vessels on the posterior surface of the lens. Here the vessels radiated from central trunks, *towards the margin* of the lens. One of

these vessels is seen in fig. 142. It was a branch, proceeding from a trunk more than three times its diameter.

170. In delicate, flat, and branchless tubes, from the edge of the lens—where red tubes have presented to me a parallel direction, from behind forwards—I have found corpuscles, having the same appearance as corpuscles of the blood, arranged with curious regularity; their flat surfaces being in contact with one another (fig. 145.). These corpuscles were blood-red, and red colouring matter was seen between or around them. For other particulars respecting these corpuscles, I refer to the explanation separately given, and to figs. 146, 147, 148; here mentioning only the brightly pellucid object in the situation of the original cavity or depression in the corpuscles. I may return to the subject of the corpuscles in these figures, in a future communication.

171. In figs. 151, 152, are portions of tubes, also from the edge of the lens. These figures are almost entirely in outline. Tubes are very frequently met with, having their contents (which resemble altered blood-corpuscles) in this state. The pellucid object arising in the centre of the corpuscle, is originally round (fig. 151.). It appears that these pellucid objects enlarge, and then coalesce with one another; the red colouring matter at the same time disappearing. By this means transparent, colourless, and very bright spaces are produced; sometimes so large as to occupy a very considerable, and even the principal, portion of the tube. But here again I must refer to the explanation of the figures; remarking only, that there was visible in some of the pellucid spaces (in fig. 152.) a minute, highly refracting object (δ), apparently an orifice communicating with the exterior of the tube (δ δ). Tubes with contents such as those in fig. 152, vary much in their diameter at different parts. I met with a tube of this kind, which, at one part measured $\frac{1}{100}'''$, then decreased to $\frac{1}{200}'''$, and then again enlarged to $\frac{1}{100}'''$: and all this variation in the diameter of the tube, was observed within $\frac{1}{10}'''$ of its length. I have frequently noticed corpuscles, having the appearance of altered corpuscles of the blood, some of which had perhaps escaped from such tubes as those last referred to. Some of these corpuscles are seen at θ and ι, fig. 142, and in fig. 143.

172. In figs. 153, 154, 155, 156, are pale cells, such as those constituting the foundation of the crystalline. As was observed by SCHWANN, there is a nucleus in many of these cells; but, as he likewise saw, there are very many in which no nucleus is found. On very closely examining the cells which had no nucleus, I have thought many of them filled with discs (fig. 153.). These discs (if I was not mistaken in the observation) had no doubt resulted from a division of the nucleus of the cell. But the cells are so very pale, that often nothing can be discerned in their interior. In figs. 156 and 159, a nucleus is seen to have divided into two parts; each of which was a disc, and presented an indication of subdivision into other discs.

173. Besides confirming, in this way, my opinion as to the mode of origin of the

contents of "cells" in general, an attentive examination of these pale cells of the crystalline has also strengthened a view mentioned in my last memoir†,—that, however minute the "cell," and wherever it exists, it is by the coalescence of discs that its membrane is formed. Thus in fig. 156. α, β, the outer discs are seen entering into the formation of the membrane of the cell; the remainder being now the nucleus of the cell. At β, fig. 154, the cell-membrane is formed. We thus seem to have even here a mode of origin of the membrane of the cell, essentially the same as that which, in a former paper, I showed to form the chorion‡,—as will be hereafter pointed out in the membrane of the ovisac,—and as seems to be the mode of production of other, and perhaps all, membranes, as well as fibrous tissues.

174. Other facts observable in an examination of the pale cells of the lens, are equally confirmatory of my views regarding "cells" in general. The nucleus is very distinctly seen to be composed of discs (figs. 154, 155, 156.), into which it divides; and at a certain part, there is sometimes seen a highly refracting object, corresponding apparently to the nucleolus of authors, but, as I believe, being really an orifice communicating with the exterior of the cell.

175. I have already mentioned my inability to confirm the idea of Professor Schwann, who supposed it to be by *elongation*, that these pale cells form the fibres of the lens. It is true he makes the addition, "I have several times observed the arrangement, one upon another, of the nuclei of cells; but do not know what it indicates. It is also very possible that the coalescence of cells may take place to form a fibre; but hitherto I have no decisive observations§." It affords me satisfaction to find that, while bringing forward facts opposed to the views of this excellent observer, I am not without an admission—very important as coming from him—of the possibility that the fibres may arise by another mode.

176. It remains to add, that the appearance now and then, in very large numbers, and in parallel lines, of objects such as those in figs. 157, 158, 159, has led me to believe that the fibre of the lens is formed by the *coalescence of the cells in question, previously arranged in a line.*

177. These fibres in many instances originally present the nucleus in their cells (see the figures). Sometimes the so-called nucleolus—really an orifice—is also present (figs. 157, 158. α), communicating with the exterior of the cell. In another instance (fig. 157. δ), I saw the cell filled with discs, there being no nucleus in this cell.

178. The fibres are originally of a necklace form; their bead-like segments being often of unequal magnitude (see the figures). When this is the case, deficiency in size is sometimes compensated by the number of the cells (fig. 158. β). It is probable that in other instances an equal diameter throughout the fibre, is obtained by elongation of the larger cell. Sometimes the cells are very large (fig. 159.). The bead-like segments coalesce; the intervening membranous partitions disappear; and thus

† On the Corpuscles of the Blood, Part II. *l. c.*, par. 79.

‡ Researches in Embryology: Third Series, *l. c.*

§ *L. c.*, p. 102.

a cylinder is formed. In the parietes of this cylinder I have noticed pellucid objects, possibly denoting the continued existence of the orifices above mentioned, as present in the nuclei. If such has been the case, it would appear that there exist communications between the interior and the exterior of the cylinder (pars. 130, 152, 162.). At all events we cannot doubt but that here, as in muscle (par. 161.), the nucleus of the original cell is the source from whence the contents of the cylinder immediately proceed: and that here, therefore, as elsewhere, we have special centres for the origin of new substance.

179. The main question, however, continues,—are the cells we have been considering, derived from corpuscles having the same appearance as corpuscles of the blood? At the surface of the lens, we saw an abundance of young corpuscles forming for some special purpose, and corpuscles, having a similar appearance, exhibiting very remarkable internal changes. Other changes are represented in fig. 155; the objects in which figure, found at the edge of the lens, had the same appearance as altered corpuscles of the blood. The two in outline (α) exhibited the characteristic red, as well as the general appearance of blood-corpuscles, in an unaltered state; excepting only, that in their irregular contour, there were some indications of a future division into discs. γ was a flattish corpuscle, composed of discs, and still blood-red. The objects δ, δ resembled γ, but were larger. The nuclei of the cells ε, ε, ζ, η, were quite red enough to show their origin to have been in corpuscles having the same appearance as corpuscles of the blood. All the objects in this figure thus presented red colouring matter,—which in α, β, γ, δ pervaded the entire object, but in ε, ζ, η was confined to the nucleus of the cell. The more or less incipient cells of fig. 156, were obviously altered corpuscles having the same appearance as corpuscles of the blood. And the remark just made, respecting colour, applies to the nuclei observed in the other cells above referred to as the elements of the crystalline (fig. 154.), as well as to the nuclei of those cells which we have seen arranging themselves to form its fibres (figs. 157, 158, 159.).

180. These are the principal observations, which have induced me to believe the crystalline lens to be derived from corpuscles of the blood. And, upon the whole, I should find it difficult to point out a line, separating the one from what are allowed to be the elements of the other.

181. It may be added, that among the figures there will be found three outline sketches (figs. 138, 139, 140.), representing appearances incidentally observed, in the course of my examinations of the Tadpole. The first of these, in a Tadpole of $5'''$, seemed the foundation of the crystalline, as it lay, surrounded by black pigment, and imbedded in the vitreous humour. It had the appearance of an altered and prodigiously enlarged corpuscle of the blood; being throughout red, except at the anterior part, α (where it was colourless and pellucid), and being filled with discs, resembling those arising in the interior of corpuscles of the blood. At the part marked β, these discs were largest, and of the deepest red. This appearance, together with those

exhibited in figs. 139, 140, observed in similar situations in others of these larvæ (for a particular account of which I refer to the explanation of the Plates), induce me farther to believe that the crystalline may have its origin in a *single* corpuscle, having the same appearance as a corpuscle of the blood.

The Elements of the Spermatozoon and those of the Ovum compared with Corpuscles of the Blood.

182. I had made the principal part of the foregoing observations,—when two others followed, which had not been at all anticipated. For, although the facts observed had led me pretty nearly to the conclusion, that every tissue in the body has its origin in corpuscles having the same appearance as corpuscles of the blood,—yet the thought, I confess, had not occurred, that the spermatozoon and the ovum might be immediately derived from the same source. It was not until the red colouring matter was noticed, by which I recognized corpuscles having the same appearance as altered blood-corpuscles, in some seminal fluid under examination, from the testis of a Bird, that the idea suggested itself, and led to a farther examination.

183. The experience gained during the long investigations, the principal results of which have been mentioned in the preceding pages, now make it easy for me to see that the "granules" which previous observers had noticed in this fluid, were masses of discs, or rather, cells filled with discs,—the altered nuclei of corpuscles having the same appearance as corpuscles of the blood. And on examining the ovary, I became equally convinced, that the object figured by myself in the Royal Society's Transactions three years since, as the ovum in a rudimental form,—while it admitted of delineation just as I then represented it,—was also derived from the same source.

184. I need scarcely mention the satisfaction afforded by these two additional observations; not only on account of their being in themselves in the highest degree interesting, and, as it appeared to me, important,—but because of the confirmation I of course believed them to give to all the rest.

185. In passing into the granular mass, or more properly, into the cell filled with discs (fig. 160.), where the spermatozoa seem to form, the nucleus of the corpuscle in question presented to me appearances in some respects similar to those which I had met with in tracing it into tissues. But I was perhaps more struck with the depth of the red colour, in the more advanced elements of spermatozoa that fell under my notice. The object fig. 161, for instance, was of a deep red. I have seen these seminal "granules" in some of the Mammalia; certain of them appearing to contain incompletely formed spermatozoa.

186. The view, however, just propounded implies another; which, so far as I know, is also new. The so-called spermatozoon appears to me to be composed of a few coalesced discs. Such has appeared to be its condition in the Rabbit, and in certain Birds. Of course the different forms of spermatozoa in different animals, sug-

gest variety in their particular mode of origin. But I have no reason to doubt that the foundation of spermatozoa in general consists of the objects I have denominated discs.

187. The corkscrew-like spermatozoon of certain Birds has presented to me appearances, which it seemed worth while to delineate (figs. 162, 163.); and I recommend that the description of these figures should be referred to; leaving it, however, for the future to determine, whether the curious division of discs in a longitudinal direction, there suggested, really takes place.

188. In a former page, I referred to a parent corpuscle (fig. 94. α) having the same appearance as the corpuscle of the blood, filled with young corpuscles, which had been destined to form epithelium-cells. I have now to mention that young corpuscles are met with, while still within their parent cell, manifesting a very different destination. The cell in fig. 164. is a parent corpuscle having the appearance of an enlarged corpuscle of the blood; and each of the contained objects is a young corpuscle. But each of these young corpuscles is also a rudimental ovum. (Compare with the ovum in my First Series on Embryology, *l. c.*, Plate V. fig. 19.) The objects also in fig. 165, though mere *discs* having the same appearance as blood-discs, are rudimental ova. Those in figs. 166, 167, 168, 169,—presenting the ovum in states somewhat more advanced,—are also altered corpuscles having the same appearance as corpuscles of the blood. Even the most forward of the objects now referred to, presented red colouring matter quite sufficient to show, to an eye accustomed to these investigations, from whence they arose. But besides this, they admitted of being traced back into corpuscles having the same appearance as corpuscles of the blood (figs. 164, 165.). And all the objects in question, it may be added, were from the ovary of the same individual Bird.

189. The essential part of the ovum in these figures, is that marked *c*. It is the germinal vesicle: very much in advance, it will be observed, of other parts, in the degree of its development (see its large size in fig. 169. γ); being, as I originally said, the first part of the ovum which is formed. Its progress admits of being traced, from merely a pellucid space—the centre of a corpuscle having the same appearance as a blood-corpuscle, fig. 165. α—through the discoid form, as in the centre of the corpuscle β—to the state of an incipient cell, as in γ of this, and in some of the other figures. I have seen the future germinal vesicle, as a disc, measuring in diameter no more than $\frac{1}{700}$th of a Paris line (figs. 164, 165.).

190. The most essential part of the germinal vesicle, is seen in many of the figures which represent the latter. While the future germinal vesicle is a mere disc, its most essential part is the depression in the centre of the surface of this disc: and when the future germinal vesicle has really become somewhat vesicular in form, there is seen an orifice in the same situation (figs. 165 γ, 166, 167.). This orifice denotes the situation of the essential part of the germinal vesicle,—the future germinal spot.

We thus find that in the minutest details, such as those which I have elsewhere described, the germinal spot and vesicle are formed like other nuclei and cells.

191. I long found it impossible to understand in what way the membrane of the ovisac, as I termed it, was formed around the mass of peculiar granules having the germinal vesicle in its interior†; and equally difficult to conceive the mode of origin of the discus vitellinus, the true yelk, and the membrane of the yelk. It now appears to me that all these (as well as the germinal vesicle and spot) originate in a corpuscle having the same appearance as a corpuscle of the blood. That part of this corpuscle which surrounds the germinal vesicle (see the figures), becomes the source of the peculiar granules (as I formerly termed them) by which this vesicle is surrounded. These peculiar granules—the objects subsequently contained within the ovisac—are not originally cells: so that the term granule proves to have been not inappropriate. The fact is, they are *discs*, having the same form and general appearance as discs in other situations (only being very red); and by a change the same as that we have so often seen elsewhere, assume a cell-like appearance, and are reproduced in the same manner as other discs. Hence, in advanced states of the ovisac, the quantity of these objects becomes very large: and, as we formerly had occasion to observe, they arrange themselves into structures, some of which—the retinacula—enter into the formation of the mechanism regulating the expulsion of the ovum‡.

192. But my purpose in referring to these discs so fully in this place, is to be enabled to make the following addition: namely, that they also give origin to the membrane of the ovisac, the discus vitellinus as well as the true yelk, and the membrane of the yelk. And as the discs in question are derived from a corpuscle having the same appearance as a corpuscle of the blood, so therefore are all these objects.

193. Delineations are given of the membrane of the ovisac thus forming. In figs. 170 and 171. the discs (*g*), quite red and large where in the neighbourhood of the germinal vesicle (*c*), were undergoing division; the young and paler discs passing outwards, increasing in size, dividing in their turn, then enlarging, and coalescing to form the membrane (*h*) of the ovisac. Traces of these coalesced discs, as well as a tinge of red, are to be discerned even after the ovisac has attained a considerable size; producing the appearance which, when first describing this membrane, I compared to that of plaits or folds.

194. I do not think that there is any essential difference between the discus vitellinus and what is called the true yelk: at least it would seem difficult to draw a line between the two. Where it is required to provide before-hand a stock of substance for fœtal use,—as in many of the Ovipara,—the discs *g* are made to form the yelk in

† First Series on Embryology, *l. c.*, pars. 14, 23.

‡ It may now be added, that the delicate membrane I described as sometimes seen investing the retinacula, and reflected from their branches to the membrana granulosa, seems to be formed by the coalescence of some of these discs.

large quantity. But in viviparous animals, these discs appear to produce little more than an object corresponding to that which in the Bird, for instance, has the form of the discus vitellinus. Fig. 173. presents these discs (*g*) rapidly dividing for the formation of the yelk in the Bird.—I refer to my First Series on the Embryo (*l. c.*, Plate V. fig. 25. *e*) for the earliest appearance of the membrane of the yelk.

195. The very minute ovisacs, myriads of which I described as found in the walls of the Graafian vesicle, seem to owe to the following circumstance their parasitic situation. The covering acquired by the ovisac consists of cellular tissue. Cellular tissue is formed out of corpuscles having the same appearance as corpuscles of the blood. But each of the minute ovisacs was once a young corpuscle of the same kind. And it appears that, while some of these corpuscles enter into the formation of the cellular tissue investing a large ovisac, other corpuscles are developed into smaller ovisacs, which therefore are found in the interstices of that tissue.

196. I have already stated that the individual discs exhibit a reproducing property. This is the case as well with those discs that have begun to enter into the formation of a structure, as with those not yet appropriated,—that is, still in circulation. With regard to the former it is to be remarked, that, in many parts, red colouring matter is reproduced along with the new discs (par. 111.), giving them quite as deep a colour as the floating corpuscles themselves; which in other respects also they resemble. Hence my general employment of the expression, *having the same appearance as* corpuscles of the blood: for it was impossible to distinguish those corpuscles which had been themselves extravasated; and I presume that, generally speaking, the term "corpuscles *of the blood*" would have been inapplicable to others, though immediately descended from them.

197. *Recapitulation.*

1. The nucleus of the corpuscle of the blood admits of being traced into the pus-globule.
2. The various structures arise out of corpuscles having the same appearance, form, and size as corpuscles of the blood.
3. The corpuscles having this appearance, and giving origin to structures, are propagated by division of their nuclei.
4. The corpuscles of the blood, also, are propagated by division of their nuclei.
5. The minuteness of the young blood-corpuscles is sometimes extreme; and they are to be found in parts usually considered not permeable by red blood.

Postscript (June 23, 1841).

198. Blood found in the heart (immediately after death by bleeding) often presents incessant alterations in the position of its corpuscles. When one of the corpuscles is

examined very attentively, it is seen to change its form; and I am disposed to think it is this change of form that produces the alterations in position. The changes of form are slight, as compared with those referred to in par. 127, and are not seen without close attention. The motions resemble that called molecular, and in the minutest corpuscles, which are mere points, nothing besides molecular motion can be discerned. It may be a question, whether molecular motion differs in its nature from the motion of the larger corpuscles just referred to. The division of the blood-corpuscles into corpuscles of minuter size, though apparent in blood from either side of the heart, has seemed more general in that from the left side; which is perhaps deserving of notice in connection with the subject of respiration.

199. (*October*, 1841.) As explanatory of the foregoing paragraph, I may perhaps be permitted to mention some appearances that have since fallen under my notice. It is necessary, however, to apprise the reader that the remarkable appearances about to be detailed are not all of them to be always found; and indeed that sometimes most if not all of them are absent. To what circumstances their presence or their absence is to be attributed, it would be premature at this time to speculate, without facts that are still wanted regarding the action of the atmospheric air upon the blood-corpuscles in their passage through the lungs; and some unknown change which, from observations not yet completed, I am inclined to think these corpuscles undergo in that portion of the circulating fluid which passes through the liver. Neither am I in possession of facts connected with the process of digestion, which may possibly influence the reproduction of the blood-corpuscle; supposing this reproduction to be effected in the way suggested by the observations of the foregoing paper, and my previous memoirs. And here I am reminded to mention, that some of the animals from which the blood in question (after death) was taken, had not received food for many hours previously. Such were the sheep at the London slaughter-houses. In these instances, therefore, the minute objects about to be described cannot be referred to the formation of chyle, and its addition to the mass of blood.

Without attaching undue importance to the circumstance, it should be stated that the blood presenting the corpuscles about to be described, was taken from the left auricle, and therefore had recently passed the lungs. In the first place, I have at different times found that there exist corpuscles much larger than the rest, and a few of them of prodigious size ($\frac{1}{50}'''$). They are, as I have seen them, always *very pale, and sometimes even colourless.* They are obviously membranous at the surface. You sometimes see them ruptured, and partially discharged of their contents. In this state, they frequently appear shrivelled. When not ruptured they are distinctly filled with young corpuscles. Secondly. The young corpuscles after liberation from the parent corpuscle, and sometimes before that change, are seen to have acquired red colouring matter. When so liberated and individualized, they present a star-like form resembling that in figs. 104 and 105. This form I have in some instances

noticed them to have while within the parent corpuscle. In a good light, these star-like corpuscles are evidently seen to be compound objects, consisting of about half a dozen segments. Each of these segments sends out a cilium; and it is by this means that the appearance of a star is produced. It is often possible to perceive these star-like corpuscles effecting alterations in their form, slowly revolving, and performing locomotion. Thirdly. Besides the two orders of corpuscles now described I have seen a third, of minuter size, apparently arising by division of those last mentioned; of which, therefore, they must have been the separated segments. Their motions were extremely vivid, and of such a kind as might be produced by the rapid vibrations of a tail-like appendage or cilium. Such cilium each of them would possess if they arise, as I think they do, by division of the ciliated corpuscles above described. Fourthly. Many corpuscles also, about the size of those last mentioned, are to be seen in the same fluid, of a star-like form. Lastly. There are others, so immeasurably small as to appear as mere points. They have precisely the same colour as corpuscles of larger size, and exhibit most vivid motions.—Some of the states now described, I have seen in the blood of the Common Mussel.

200. Explanation of the Plates.

PLATE XX.

Fig. 63. Man. Corpuscles found in fluid having nearly the colour of blood, taken from an abscess. This figure shows the young corpuscle of the blood becoming changed into the pus-globule. See par. 101. for the details of this change. In the objects presented by this figure, proceeding from left to right, a gradual enlargement was observed, as well as a change from the flattened to the globular form; and those on the extreme right had lost, in some degree, the peculiar tint characterizing the corpuscle of the blood. (The more or less altered blood-corpuscles in the fluid from which this figure was taken, were observed to arrange themselves into rouleaux, like those in blood unaltered.)

Fig. 64. Man. Globules and cells from well-formed pus, after the addition of (α) acetic acid, and (β) dilute spirit.—α. The largest globule was still surrounded by, and eccentric in, an elliptical cell, which is shown in outline. A corresponding cell had perhaps disappeared from around the other globules; for many such cells were seen in this pus, before any addition had been made. When a cell is present, the pus-globule is the nucleus; and its eccentric, highly refracting portion, is the nucleolus. The pus-globule is composed of elliptical discs; those forming the nucleolus having a high refracting power, after, as in this instance, the addition of acetic acid. The nucleolus consists of either a

single disc, or two or three discs. Where the discs of the nucleolus lie one on the other, the degree of refraction is very small. β. Similar objects, as viewed after the addition of dilute spirit. Each of the two lower ones has the appearance of being circumscribed by a membrane, and is contained within a minute cell. The upper object presents three layers of discs; the outer layer being pale.

Fig. 65. Man. Fragment of a capillary vessel, found in the pus of the preceding figure. It is filled with altered corpuscles of the blood. The largest corpuscle presented an appearance resembling that of the pus-globule. (Acetic acid.)

Fig. 66. Man. Altered blood-corpuscles, observed in fluid from abscesses.

Fig. 67. Man. Altered blood-corpuscles, observed in fluid from the intestinal canal, where the existence of pus was suspected (compare with fig. 63.). α Corresponds, apparently, to the "lymph-globule" of authors.

Fig. 68. Man. Globules and cells in mucus from the air-passages of a healthy person. This mucus had in some parts a slight tinge of yellow. (Acetic acid.)

Fig. 69. Man. Globules and cells in mucus from the air-passages of a healthy person. This mucus was a tenacious, colourless, pellucid fluid. (Acetic acid.)

Fig. 70. Man. Cells in mucus from the Schneiderian membrane. The discs blood-red. (Acetic acid.)

Fig. 71. Man. A later stage of apparently corresponding objects, taken from the same part. (Acetic acid.)

Fig. 72. Man. From blackish mucus of the air-passages. α. Corpuscle having the same appearance as a young corpuscle of the blood; blood-red. β. Mass of blood-red discs; which had the appearance of an altered corpuscle of the blood. Such also was the appearance of γ, δ, ε, ζ. γ In outline: colour blood-red. This object was elliptical, and presented an orifice at one end; the orifice occupying the situation of the depression existing when the corpuscle had a discoid form. The object γ was composed of discs. δ, ε. Similar objects; but presenting numerous black points. Some of these black points are seen to have been in the centres of the discs, and others between the discs. The orifice was less distinct in ε; but there was a pellucid part in the same situation. ζ. Outline of a later state of the last-mentioned object.

Fig. 73. From the same mucus. α. Corpuscles, having the same appearance as young corpuscles of the blood. They were of the characteristic colour of blood-corpuscles, and exceedingly minute, but not the minutest seen; mere points having been observed in large number, of the same colour, and apparently derived from the same source. β. Outline of

similar corpuscles, arranging themselves into fibres, and then exhibiting indications of division into discs still more minute. γ. Outline of corpuscles of the same kind, arranging themselves into a cellular tissue-like object, and at the same time undergoing division into discs. β, γ. Blood-red.

Fig. 74. Tadpole of the large Toad of Jersey; about 6‴. α. Young blood-corpuscles; some of them exhibiting an orifice. Colour, pale red. β. Young blood-corpuscles of a deeper red.

Fig. 75. Tadpole, about 6‴. Blood-corpuscles; partly in outline. α. The minute red points around the nucleus in this corpuscle exhibited molecular motions. β. Discs are seen in the situation occupied by the minute red points in α; these discs pressed into polyhedral forms.

Fig. 76. Pale objects, composed of discs, from the blood of the same Tadpole. They correspond apparently to the "lymph-globules," or "corpuscles of the second form," of authors. α. The discs are numerous and minute. β. Discs fewer and larger. γ. The object in two portions,—perhaps a nucleus (eccentric), and an incipient cell; the nucleus composed of pale discs,—the surrounding part reddish. Discs were distinctly visible in this surrounding part also.

Fig. 77. Water Newt. Outline of blood-corpuscles, some of which were observed to contain blood-corpuscles, besides their nucleus.

Fig. 78. From the same. Objects found with blood-corpuscles,—all in outline except one. The latter, much enlarged, is seen to have been filled with, or made up of, discs; which was the case with all the rest. These objects appear to correspond to the "lymph-globules" of authors.

Fig. 79. From the same. Outline of a blood-corpuscle, and of the discs contained within it. The central object is the nucleus. (Acetic acid.)

Fig. 80. From the same. Outline of blood-corpuscles and their nuclei, as seen after the addition of an aqueous solution of nitrate of silver. The interior of one of the nuclei is shown. It was filled with discs, as were all the others.

Fig. 81. From the same. Outline of two blood-corpuscles, as viewed after the addition of a solution of corrosive sublimate. The interior of the nuclei is shown. α. In the nucleus were discs of about equal size. β. The nucleus presented discs at its central part; around which there was a space, apparently occupied by discs in a more advanced state and larger.

Fig. 82. Green Lizard. Corpuscles of the blood. α. Outline of one of these. β. Two corpuscles, the nuclei of which were composed of discs. γ. Corpuscle filled with discs. δ. Disc of the same colour as the corpuscles of the blood: perhaps a young corpuscle.

Fig. 83. Outline of blood-corpuscles from the egg of the Duck, incubated about 12 days.

Fig. 84. Blood-corpuscles, chiefly in outline, from the same egg. They are apparently in a stage more advanced than those in the preceding figure, with which, however, they were mixed. A nucleus, composed of discs, has been represented in some of these; and in one of the corpuscles, discs are seen surrounding the nucleus.

PLATE XXI.

Fig. 85. Tadpole, about 5‴. From the tail. Outline of epithelium-tables, having essentially the same appearance as blood-corpuscles circulating in the vessels of this larva. The peripheral portion of the six-sided tables resembled that of the object fig. 89.

Fig. 86. Tadpoles, about 5‴. Epithelium-tables, from the tail. α, β. Removed from the lacerated edge of the tail. α Is in outline. The form and size are here seen to have been very much the same as those of the blood-corpuscle in this larva. The same remark applies to the interior of this object, which is not shown in the figure. The envelope was also membranous. β. The germinal vesicle-like nucleus eccentric, and scarcely coloured: the discs on the nucleus, blood-red. The other objects in this figure were seen *in situ*. γ Resembled β, but it was membranous at the surface. $\delta, \delta, \varepsilon, \zeta$, Resembled the ovum in their interior, and were blood-red at the surface.

Fig. 87. Tadpole, about 5‴. From the tail. Outline of the appearance presented by an epithelium-table undergoing division. (Dilute spirit.)

Fig. 88. Tadpole, 6‴. From the tail. Outline of three stages in the reproduction of epithelium-tables, having a situation corresponding to that of the large objects (centres) connected with pigment ramifications in figs. 90 and 91. The object on the left hand (in fig. 88.) represents the earliest, and that on the right the most advanced, of these three stages. These tables propagate by division, like every other disc. Each of the objects in this figure consisted of two parts; of which α was dark,—the other, β, colourless and pellucid. α. Oldest and largest tables; β, newest and smallest tables,—mere discs. In the centre of β, in the largest object, there was seen a part still more pellucid. β Is not in the centre of the object, but on one side. This corresponds with the situation of the most essential part in all other discs. In some instances, the number of parts into which objects such as those in the present figure were dividing, was observed to be four; this having been a stage still earlier.

Fig. 89. Tadpole, about $5'''$. Peripheral parts of several epithelium-tables, consisting of red discs, which (red discs) enter into the formation of the so-called ramifications of pigment (par. 118.). The central portion of the epithelium-tables here seen, appeared to be dividing into four parts, which, with a pale surrounding substance, are represented in outline only. From the tail.

Fig. 90. Tadpole, about $5'''$. A later stage of partitions (pigment ramifications) such as those in fig. 89, together with an object of a deep red colour, and an ovum-like interior. It is a centre for the origin of new epithelium-tables. From the tail.

Fig. 91. Tadpole, about $5\frac{1}{2}'''$. Appearance presented by portions of the choroid, arisen in the manner described in par. 118, as that in which the ramifications of black pigment in the epithelium of the tail have their origin. One of the objects is in outline. The so-called ramifications are really partitions; but not represented as such in the figure, which is intended to show no more than their appearance on a superficial view.

Fig. 92. Man. Objects from the surface of a furred tongue. α, β. Outline of epithelium-cells. Their contents, more or less red discs, which were reddest the nearer they were to the nucleus, excepting that in α the very red nucleus was surrounded by a more pellucid space, apparently occupied by larger discs. In β, the nucleus was very large; its pellucid nucleolus measuring as much as the nucleus of α. The nucleolus of β seemed to contain pale discs. γ. Outline of a mass of pale blood-red discs.

Fig. 93. Tadpoles, about $5'''$. Pigment of the eye, forming out of objects resembling corpuscles of the blood. The part marked ζ is that which had become the blackest. α. Four young blood-corpuscles, observed, along with others of the same kind, in the choroid. They had probably arisen in a manner analogous to that giving origin to the objects at α fig. 94. Three of these young corpuscles are in outline. They were composed of discs; and in the finished one, a pellucid nucleus was visible on one side. They were blood-red. β, γ. From the same part. β For the most part bright red, but approaching black in some parts. A nucleus visible in each,—distinctly in β, obscurely in γ. An orifice on one side in the nucleus of β. δ. An object somewhat resembling β. The nucleus excepted, it was blood-red. ε. Part of an object of the same kind as δ. ζ. Partitions between spaces, such as those occupied by δ and ε; at first sight appearing black, but, when more closely examined, found to be of a reddish colour. The discs of the bright red δ and ε undergo division, and are given off, to enter into the formation of the darker and blackish ζ. It appears that what is seen of ζ in the figure,

had been formed by portions previously given off in this manner from the centre δ. The object now described, on the right hand in the figure, was lying on the crystalline. I have seen similar objects in the choroid. The mode of origin of the partitions ζ, just described, is precisely analogous to that of the partitions in fig. 89, from the tail.

Fig. 94. Tadpole, about 6‴. α. Outline of a cell, filled with young epithelium-cells. This cell was red throughout. The cells which it contained, presented indications of further division, as seen by the one somewhat more finished, in delineation, than the rest. And at the left side, one of these young cells was broken down into cells or discoid objects of extreme minuteness. β. Two epithelium-cells, of a blood-red colour, except at the lower part, where they had become quite black. (Acetic acid.)

Fig. 95. Tadpole, about 6‴. Blood-corpuscles, apparently forming epithelium. All of these contained discs or incipient cells, which, generally speaking, had a deeper red, the nearer they were to the centre of the enlarging nucleus. The nucleus increased so as nearly to fill its corpuscle. In α, it consisted of a central portion, composed of four cell-like objects; and of two parts, concentrically arranged around these. β. The corpuscle is in outline. Four cell-like objects were seen within it, each of which was filled with discs. (Acetic acid.)

Fig. 96. Tadpole, 5‴. Epithelium-cell, having very much the appearance of an altered corpuscle of the blood. At β, it was nearly black; at most other parts, blood-red. Discs were seen, with more or less distinctness, at nearly all parts. At α, the surface was membranous; and internal to this portion of membrane, the substance was of a pale red, and free from the very highly refracting globules so numerous elsewhere in this object. At a certain part, is seen the nucleus; pale in colour, and in some degree pellucid. It presented discs.

Fig. 97. Tadpole, 5‴. An object entering into the formation of the epithelium, and for the most part blood-red. The eccentric nucleus exhibited a nucleolus, having apparently a peripheral situation. This nucleolus seemed to be an orifice, possibly communicating with the exterior. (Tincture of iodine.)

Fig. 98. Tadpole, about 5‴. Incipient epithelium-cylinders. Colour red, passing at the large extremity almost into black. Some of the discs composing the object α, were in motion, effecting changes in their form: and the object very slowly revolved on its axis, in the direction of the arrow. β. The same object, as viewed about half an hour after it presented the appearance at α. Its form was different. This may have arisen partly from a change in its direction,—the part which is pointed in β, having possibly been, in the condition α, directed towards the

observer. But it appeared that some alteration had really taken place in the form. A further change was noticed. The discs of the dark part in the condition α, were very indistinct. In the state β, they were well defined, and presented the appearance of little cylinders: which appearance was noticed also in the paler part of β. Motion not observed in the condition β. γ. State rather more advanced. The nucleus presented an orifice, having the appearance of a rent or fissure. The red colour was very deep. δ. Two of the appearances presented by a minute and isolated disc which was in motion,—changing its form and place.

Fig. 99. Tadpole, $5'''$. An object, which was apparently an epithelium-cylinder, about to undergo longitudinal division. It contained two nuclei; one in a more advanced state than the other. Each of these was composed of discs, situated in concentric order around a space representing the nucleolus. This object was blood-red. (Tincture of iodine.)

Fig. 100. Tadpole, about $5'''$. More advanced state of a corresponding object. The two nuclei pale. The surrounding part blood-red, passing nearly into black at some parts, especially at the lower end.

Fig. 101. Tadpole, about $5'''$. Outline of portions of ciliary processes; the parts composing them having the same appearance as corpuscles of the blood.

Fig. 102. Duck. α. A cell observed lying among blood-corpuscles taken from the surface of the yelk, in an egg incubated five days. It had the same colour as the corpuscles of the blood. The membrane of this cell was of extreme delicacy. It contained a pale yellow substance, in which were globules, yellowish in colour, highly refracting light, and in vivid molecular motion. These motions were not observed when the cell was first seen; at which time, also, the contained globules were in closer approximation than the figure shows. Possibly the cell was ruptured while under examination. β. Similar globules, myriads of which were seen loose in the same field of view. Their molecular motion was most vivid, and attended with constant and considerable change of place.

Fig. 103. Tadpole, $4\frac{1}{2}'''$. The larger object is a blood-corpuscle, and contents, for the most part in outline, very much enlarged. The interior presented globules resembling those of fat. These globules appeared to occupy the situation of the central part of what had previously been discs. Compare the disc α, and its centre, with apparently corresponding objects at β. The corpuscle exhibited redness at all parts, but chiefly on the side γ,—where, here and there, it was very dark,—though this appearance has not been at all represented in the figure. Something

like a nucleus was visible at δ. The smaller object is a blood-corpuscle of nearly the size usually met with. It also is, for the most part, in outline. It appeared to be an early state of such an object as the larger one. δ. Situation of the nucleus.

PLATE XXII.

Fig. 104. Ox (*Bos Taurus*, Linn.); fœtus of $5\frac{1}{4}$ inches. Nuclei of blood-corpuscles furnished with cilia, and changing their place. Colour blood-red. Two of them in outline. α. Observed in substance cut with scissors from the crystalline lens, while the lens was still imbedded in the vitreous humour; so that a portion of each may have been placed in the microscope. Two days had elapsed since the fœtus was taken from the body of its mother. β. Seen along with a portion of the retina and black pigment, from the other eye. The discs of this corpuscle appeared to shoot forth a process—the cilium—which then disappeared, as if drawn in. This corpuscle, as well as those at α, crawled about like an insect; but very slowly.

Fig. 105. Rabbit (*Lepus Cuniculus*, Linn.); killed two hours, *post coitum*. Blood-corpuscles and nuclei of blood-corpuscles observed in fluid taken from vessels in the immediate neighbourhood of a Graafian vesicle, which, from its size and vascularity, had evidently been destined to expel an ovum. α. A group of young blood-corpuscles. β. Outline of the nucleus of a corpuscle, one of the projections (altered discs) in which, appeared to be in motion. γ, γ, γ, γ. Four ciliated corpuscles, —or rather, ciliated nuclei of corpuscles,—of the blood. The cilia seem to be the filamentous extremities of discoid objects, into which the nucleus of the blood-corpuscle becomes divided. Objects such as those at γ, were seen very gradually to change their place; and others, of similar forms, were noticed to revolve; both of these effects seeming referable to their cilia. Examined eighteen hours after death. Among the corpuscles in this figure (and therefore apparently from the interior of a blood-vessel), were many objects of immeasurable minuteness, exhibiting molecular motions. These minuter objects had precisely the red colour of corpuscles of the blood, in which they probably had their origin (see par. 167.). δ. Outline of the nucleus of a blood-corpuscle, composed of discs not terminating in cilia, like those of γ.

Fig. 106. Common Fowl (*Phasianus Gallus*, Linn.); chick *in ovo*. Young blood-corpuscles observed in the immediate neighbourhood of the object fig. $116\frac{1}{2}$. One of these is in outline. They were blood-red. These young blood-corpuscles, with others of the same kind, were in constant

motion; effecting a change of place (see par. 126.). Examined twenty-four hours after death.

Fig. 107. Ox; fœtus of eighteen inches. From the retina. Capillary vessels, forming out of corpuscles, having the same appearance as young corpuscles of the blood. These corpuscles, while still red (α), apply themselves together so as to form a necklace-like object, composed of elliptical beads: and having coalesced, and become pale (β), and the membranous partitions having disappeared, they form a tube. The corpuscles seem to apply themselves at certain parts in such a manner as to form a branched vessel. Resolving themselves (here, as well as when forming other tissues) into discs, the corpuscles contain within themselves the elements of new corpuscles. See α in the upper part of the figure. γ. Group of blood-corpuscles, and what seemed parts of blood-corpuscles (chiefly in outline), which may serve as a specimen of the many forms of these corpuscles, observed along with the foregoing. The central corpuscle in this group, resembles one of those marked β in fig. 63; where the nucleus of the blood-corpuscle is forming the pus-globule. (Blood-vessels seen forming in the same manner, and out of similar objects, in the retina of a chick; the egg incubated ten days.)

Fig. 108. Ox; fœtus of about seven inches. Outline of blood-corpuscles, observed among fibres from a muscle of the thigh. Most of these corpuscles were orange-shaped or globular, and exhibited an orifice. Some of them presented discs in their interior. The minutest objects in this figure were of the same colour as the larger ones,—blood-red.

Fig. 109. Ox; fœtus of about seven inches. Corpuscles having the same appearance as blood-corpuscles, observed among fibres from a muscle of the thigh. They appeared to be passing into the elements of cellular tissue. α. The corpuscle has one large orifice. $\beta, \beta, \beta, \beta, \beta$. It exhibits two or more small orifices. γ. The corpuscle has passed into a mass of discs; this mass being, not cylindrical, but flattened. In such objects as β and γ, the outline of discs is hidden, apparently, by red colouring matter.

Fig. 110. From the same. Altered corpuscle, having the same appearance as a corpuscle of the blood. It had become a mass of discs resembling those marked γ in fig. 109, but terminated at each extremity in a fibre; thus presenting a more advanced stage in the formation of cellular tissue.

Fig. 111. Ox; fœtus of about five inches. Altered corpuscles having the same appearance as blood-corpuscles, passing into cellular tissue. The filaments into which the corpuscles are prolonged, consist of coalesced discs. Colour quite red. Taken from under the superficial muscles of the neck.

Fig. 112. Ox; fœtus of five inches. From the axilla. Three altered corpuscles having the same appearance as corpuscles of the blood. α. Many bright points seen (par. 134.). β. Discs now visible. γ. Some of the discs have enlarged, while others have divided into smaller discs, which are coalescing, and thus entering into the formation of the filaments of cellular tissue, with the elements in themselves of further perpetuation. This corpuscle (γ) was bent, from its position in relation to β. (Tartaric acid.)

Fig. 113. Ox; fœtus of five inches. Altered corpuscle having the same appearance as a blood-corpuscle, passing into cellular tissue. (Transition unequivocal.) From the axilla. (Citric acid.)

Fig. 114. Rabbit; killed two hours *post coitum*. From the fimbriated extremity of the Fallopian tube. Cellular tissue, forming out of altered corpuscles having the same appearance as corpuscles of the blood.

Fig. 115. Tadpole, about $6'''$. Outline of altered corpuscles having the same appearance as corpuscles of the blood. They are composed of discs, entering into the formation of cellular tissue. All the objects were pale red; and the transition out of corpuscles having the same appearance as unaltered blood-corpuscles was observed.

Fig. 116. Tadpole, $5'''$. Outline of incipient cellular tissue, composed of discs. It was forming out of corpuscles having the same appearance as corpuscles of the blood; and still red. This cellular tissue lay around the spinal chord, at a part where the latter had a diameter of $\frac{1}{20}'''$; being apparently in the course of forming the sheath of the spinal chord. α. The outer part of this cellular tissue. β. A part of the sheath more internal; consisting of minuter discs. (Acetic acid.)

Fig. 116½. Common Fowl; chick *in ovo*. Outline of what seemed to be the foundation of two portions of cartilage in the wing, in an extremely early stage (par. 145.). These were composed of very large cells, filled with other cells. Colour pale red. The large cells had the appearance of altered blood-corpuscles. α. Some of the inner cells are seen; β, none but the outer cells. The nuclei of the inner cells in α were blood-red, and not distinguishable from the young blood-corpuscles fig. 106, lying near. (Some of the nuclei of the inner cells in β presented the same appearance; while others were larger and paler.)

Fig. 117. Tadpole, $5'''$. Portion of the foundation of a cranial vertebra, composed of corpuscles having the appearance of more or less altered corpuscles of the blood. The round objects are the *nuclei* of the corpuscles. Two of the entire (elliptical) corpuscles are seen of an unaltered shape. All in outline except two of the nuclei. All the nuclei filled with discs.

Fig. 118. Tadpole, $6'''$. Cells entering into the formation of cartilage, apparently

part of the foundation of the orbit. They are in outline only; the nuclei rather more finished. The latter presented discs. α. The cell contained two nuclei, besides discoid objects. The former and a few of the latter are represented in the figure. These discoid objects probably resulted from decomposition of the outer part of one of the nuclei,—thus rendered smaller than the other. (The contents of the other cells are not represented in the figure.) (Essentially the same state observed in the foundation of a vertebra, in a Tadpole of $7'''$.)

Fig. 119. Common Fowl; chick *in ovo*, on the tenth day of incubation. Elements of cartilage. (Foundation of a bone—diameter $\frac{1}{7}'''$—in one of the lower extremities.) Partly in outline. Red colouring matter still present in the objects β; which, however, were paler than the objects α. Those at β formed a dense mass. (Portions of incipient vertebræ seen in a similar state from the same chick (fig. 122.); substance also from the extremity of a duck's bill, and from its claw (thirteenth day of incubation), observed to be in essentially the same state, and with a corresponding transition out of corpuscles, having the same appearance as corpuscles of the blood.)

Fig. 120. From the same object as fig. 119. Appearance, chiefly in outline, of the marginal portion.

Fig. 121. Tadpole, $5'''$. Portion of the cartilaginous foundation of one of the orbits; composed of the nuclei of corpuscles, resembling corpuscles of the blood. Colour red.

Fig. 122. Objects from the foundation of a transverse process of one of the vertebræ in the chick from which fig. 119. was taken. α. Blood-red corpuscles composed of two or three discs. They resembled altered young blood-corpuscles. These appeared to be entering into the formation of the cortical portion of the transverse process, in which objects such as those at β occupied a less superficial place.

PLATE XXIII.

Fig. 123. Tadpole, $4\frac{1}{2}'''$. Outline of corpuscles having essentially the same appearance as blood-corpuscles, collected to form the optic nerve. Taken from a part of the nerve, just before its entrance into the eye-ball, which part measured in diameter about $\frac{1}{20}'''$. One of the corpuscles is not merely in outline; the peripheral part being represented in a more finished state. The central portion however—nucleus—is not shown. At the periphery are seen minute, highly refracting, red discs, dividing into minuter discs. The nerve did not present any fibres, the corpuscles being merely in contact with one another. In another instance, where

the part was more advanced, the surrounding globules had very much disappeared; and the corpuscles were in polyhedral forms.

Fig. 124. Tadpole, about $5'''$. Corpuscles having precisely the same appearance as blood-corpuscles, passing into the elements of the optic nerve. Taken from various parts of a fasciculus of incipient fibres in the immediate neighbourhood of the eye-ball, which the fasciculus was seen to enter. α. The corpuscles in question arranging themselves in a line. These are all in outline except one. Immediately within their membrane was red colouring matter. This surrounded a pale globular object (nucleus), in which were discs. In the red colouring matter, there were seen very minute globules, having a high refracting power. These were of a brilliant red colour. Many of them appeared to be undergoing division. They presented the appearance of a rose. These globules occupy the situation of such as are seen, in many instances, to exhibit molecular motions in corpuscles of the blood.—All the other objects in the figure were composed of discs; and all were red, the colour becoming paler in the more advanced.

Fig. 125. Tadpole, about $7'''$. Portions of the optic nerve, forming out of corpuscles having the same appearance as corpuscles of the blood. Quite red. Almost entirely in outline. α. The discs into which the nuclei of the said corpuscles had passed, were arranging themselves in something like lines; and they presented discs in their interior, as in the more finished disc of this object. β. From a part of the same nerve, more advanced. This object is a tube, at the periphery of which there were seen discs coalescing. These discs presented discs in their interior, corresponding apparently to the minutest of those in the object α. Pellucid points, apparently orifices, were seen here and there; and they seemed to communicate with the exterior of the incipient tube. (Dilute spirit.)

Fig. 126. Ox; fœtus of eighteen inches. From the retina. Two corpuscles having the same appearance as corpuscles of the blood. α. But little changed. β. Orange-shaped; a large orifice in the situation of the original depression (which existed when the corpuscle was a disc). Two pellucid points on one side (par. 154.). (Dilute spirit.)

Fig. 127. Ox; fœtus of ten inches. From the retina. Two altered corpuscles having the same appearance as corpuscles of the blood. α. The orifice is very large; but single. β. There exist two orifices (par. 154.).

Fig. 128. Sheep (*Ovis Aries*, Linn.); fœtus of eight inches. Corpuscles having the same appearance as corpuscles of the blood, passing into globules for the formation of the retina. See the description of fig. 130; the letters denoting similar objects in both figures.

Fig. 129. Ox; fœtus of eighteen or twenty inches. Objects from the retina, as seen after the addition of acetic acid. (See the description of the following figure.)

Fig. 130. From the same fœtus. Elements of the retina, formed of corpuscles, having the same appearance as corpuscles of the blood. α, β, γ, Are such corpuscles, passing into globules. α. They have undergone but little change. β. Two or more pellucid points are seen in each corpuscle (par. 154.). γ. The globule is now seen to be composed of discs. δ. A cell, the nucleus of which consists of several discs. ε. Cell rather larger than that at δ. Its nucleus, which had a similar appearance, is in outline. ζ. Cell, the nucleus of which was surrounded by a space more pellucid than the rest of the cavity of the cell. The whole in outline. η. Cell, in the nucleus of which are seen five discs. The cavity or depression in one of these was very large; and probably indicated the situation of the orifice in the membrane of the cell. θ. Very large cell. Its nucleus consisted of two parts. One of these was dark, and globular in form. The other part surrounded that just mentioned, and consisted of many globules. Each of the globules (in both parts) was composed of discs, which were circumscribed by a delicate membrane. The whole nucleus, also, was similarly circumscribed. ι. Spindle-shaped object, composed of discs, possibly representing an altered state of a globule such as γ,—the first change being seen at $\varkappa$. When passing into the elements of the retina, corpuscles having the same appearance as corpuscles of the blood seem to continue longer of a flattened form than is usual elsewhere; γ, for instance, being rather orange-shaped than globular. All the nuclei (δ, ε, ζ, η) were circumscribed by a delicate membrane.

Fig. 131. Tadpole, $4\frac{1}{2}'''$. Objects derived from corpuscles having the same appearance as corpuscles of the blood, entering into the formation of the elements of the retina. (The transition observed, though not represented in the figure.)

Fig. 132. Tadpole, about $5\frac{1}{2}'''$. Outline of corpuscles having the same appearance as slightly altered corpuscles of the blood; as seen entering into the formation of the spinal chord. In one of these corpuscles, are delineated the objects which were seen surrounding the nucleus. (Dilute spirit.)

Fig. 133. Ox; fœtus of $5\frac{1}{4}$ inches. From the cortical portion of the brain, in which objects such as those in the figure were observed in large numbers,—often seen to be flattish in their form. They were all more or less red, some blood-red, the difference being in some degree represented by the shading; all were either discs themselves, or composed of discs; and

all were either corpuscles themselves, having the same appearance as blood-corpuscles, or immediately derived from such corpuscles. The less advanced of these objects had the same appearance as young blood-corpuscles; these passing into the objects more forward. $\alpha, \beta, \gamma, \delta$, Presented exactly the same appearance as young corpuscles of the blood. α Becoming orange-shaped,—blood-red; β, nearly globular,—an orifice in the situation of the original depression presented by the corpuscle when discoid in form: paler, yet blood-red. γ. Discs visible, yet indistinctly, from the presence of red colouring matter. Dark blood-red. δ. Paler, yet still blood-red. ε Resembles δ, but is more advanced,—being paler, and the discs being more distinct. ζ. Two sets of discs, an inner and an outer; the inner, deep red,—the outer, pale red. This seems to correspond to ε more advanced; the inner discs of ζ occupying the situation of the pellucid centre of ε. η, η. Three concentric parts,—namely, first, an outer part, consisting of pale and nearly colourless discs—this being the oldest part of the corpuscle;—secondly, a middle part, composed of blood-red discs (obscured in one, distinct in the other),—this part being the next in age;—thirdly, a central, round, blood-red object, pellucid in its middle, which is the newest part. θ. A mass of blood-red discs.

Fig. 134. Objects from the medullary portion of the brain in the same calf; observed along with such as those in the preceding figure. The same general remark as that in the explanation of fig. 133, respecting discs, form, colour, and origin in corpuscles having the same appearance as blood-corpuscles, is applicable here. α, β. Young blood-corpuscles; both blood-red. β Is passing into discs. γ. Mass of quite red discs. δ. The outer discs almost colourless; the middle set, as well as the central part, still red. Compare with η, η of fig. 133, of which δ in the present figure seems to be a more advanced state. The pellucid object in its central part, more defined. (Compare with the remarks in the explanation of fig. 43 β in Part II.) ε. Discoid, and very pale; yet reddish. These objects were present in large numbers, and contained discs themselves. They resemble in some degree the corpuscles from which they are derived. Not generally seen in rows.

Fig. 135. Common Fowl; chick *in ovo*. From the leg. Cells having the appearance of altered young corpuscles of the blood. Quite as red as blood. α. Outline of some of these arranging themselves to form muscle. β. Another, exhibiting the internal state. It was filled with discs;—outer part of the nucleus, a layer of very minute discs. The inner part of the nucleus consisted of finely granular substance. Centre, an orifice (par. 161.). (Dilute spirit.)

Fig. 136. Same chick. Outline of corresponding cells, from the same part, and in a more advanced state. The nuclei presented indications of division into discs (par. 161.). (Dilute spirit.)

Fig. 137. From the leg of the same chick. Outline of a muscle-cylinder, containing discs, a few of which are represented in the figure. The partitions between the original cells which form the cylinder, have disappeared. The nuclei were parietal, and composed of discs. The nucleus finished in delineation, exhibits these discs in concentric layers, around an orifice, communicating with the exterior of the cylinder (par. 161.). (Dilute spirit.)

Fig. 138. Tadpole, $5'''$. Outline of part of the foundation of the crystalline lens, as it lay surrounded by black pigment, and imbedded in the vitreous humour. It had the appearance of an altered and greatly enlarged blood-corpuscle; being throughout red,—except at α (the anterior part), where it was pellucid,—and being filled with discs resembling those arising in the interior of a corpuscle of the blood. These discs were largest and darkest at the part β.

Fig. 139. Tadpole, about $5'''$. Outline of cells forming a portion of the crystalline lens. They were very pale, yet tinged with red. Red colouring matter was seen between the cells. The interior of all these cells presented discs; and here also was observed red colouring matter. The cell, the interior of which has been delineated in the figure, was brighter than the rest, and its discs were more defined. On being viewed repeatedly, for a considerable time, the appearance of the interior of this cell was found to vary, *apparently from the discs changing their position.* This cell possibly corresponded to the central cell in fig. 140.—(Surrounding the incipient lens, there was forming a membrane,—perhaps the membrane of the lens. It seemed forming by the coalescence of objects, redder and less pale than those in the present figure; and in just the same manner as the membrane of the ovisac (fig. 172.). The crystalline and its membrane may perhaps arise, like the ovum and its ovisac, from a *single* corpuscle having the same appearance as a corpuscle of the blood (par. 181.)).

Fig. 140. Tadpole, about $5'''$. Appearance of a part, probably the centre, of the crystalline lens; the lens measuring in diameter $\frac{1}{20}'''$. The object α was dark red; the branched substance around it, very pale, yet reddish. The latter extended, in the same branched form, to the edge of the lens.

Fig. 141. Sheep; fœtus of eight inches. Objects observed in a portion of the crystalline lens, cut with scissors from the surface. The field of view presented a large number of capillary vessels, having a diameter of $\frac{1}{600}'''$

to $\frac{1}{100}'''$, and filled with red blood. One of the minutest is seen at α. The corpuscles in it were pressed into irregular forms. α, α. Some of the same vessels, in outline. β. Corpuscle of the blood, filled with young corpuscles; these being mere discs, elliptical, and differing from other discs only in being redder. γ. Outline of two of the same parent-corpuscles, which were filled, in like manner, with young corpuscles; their membranes shrivelled. δ. Parent-corpuscles of the blood, ruptured, and from which young corpuscles were escaping. Some of the latter were still elliptical; while others had become round, but continued flat. ε. Young blood-corpuscles, larger than those at δ.

PLATE XXIV.

Fig. 142. Ox; fœtus of ten inches. From the posterior surface of the crystalline lens. Vessels here radiated from central trunks, towards the margin of the lens. On the left hand in the figure, are three corpuscles having the appearance of much altered corpuscles of the blood. A few blood-corpuscles have been represented in the portion of vessel figured. It contained many not here shown. Most of the corpuscles figured, as well as the vessel itself, are in outline. α. Young blood-corpuscles, still elliptical, mere discs, and red. β. Blood-corpuscle in nearly the usual state. γ. Form altered, but the corpuscle still quite red. δ. Blood-corpuscles dividing into discs, and of a paler red. ε. This division of the blood-corpuscle into discs, has proceeded farther; and the effects are seen of the same process as that which forms cellular tissue (par. 134.). ζ. Pale discs, derived from blood-corpuscles. η. Corpuscle having the appearance of an altered corpuscle of the blood. It consisted for the most part of pale red discs. Two of the discs presented by this corpuscle, were of a deeper red, and had a darker outline. These occupied the situation of the original orifice, and afford a remarkable instance of the identity of the process effecting changes in corpuscles, having the same appearance as blood-corpuscles, with that producing the first alterations, *post coitum*, in the mammiferous ovum; and also of the similarity between the changes producing pus-globules, and some other objects. θ. Corpuscle, having the appearance of a blood-corpuscle very much enlarged. It was colourless and brilliantly pellucid in the situation of the original orifice; and at the part surrounding this, the corpuscle was blood-red, presenting indications of the formation there of discs. ι. Similar state of a corpuscle of smaller size.

Fig. 143. Common Fowl; chick *in ovo*. Corpuscle in a state analogous to that of β. fig. 155. and of θ and ι, fig. 142; and also having the appearance of an altered blood-corpuscle. It was observed, along with many others, having a similar condition, in the neighbourhood of the crystalline lens. Shreds also were seen, composed of corpuscles in the same state.

Fig. 144. Ox; fœtus of eighteen inches. From the edge of the crystalline. Portion of a tube filled with corpuscles having the same appearance as young corpuscles of the blood. A few of these are represented in the figure. Where shaded, the corpuscles were red; where the corpuscles are in outline, the red colouring matter had disappeared. They were mere discs. α. The corpuscle was red in the centre (the situation of the original cavity or depression), and colourless in the surrounding part.

Fig. 145. Sheep; fœtus of six inches. From the edge of the crystalline lens. Portion of a flattish tube, filled with corpuscles having the same appearance as corpuscles of the blood. These corpuscles, most of which are represented in outline only, were arranged with great regularity; their flat surfaces being in contact with one another. They were blood-red, and red colouring matter was seen between or around them.

Fig. 146. Another part of the same tube, filled in a like manner, but much smaller in diameter, and exhibiting a space unoccupied by corpuscles. The membrane of the tube very delicate.

Fig. 147. Another portion of the same tube. The corpuscles exhibited a brilliantly pellucid object in the situation of their original cavity or depression; their external part being still red.

Fig. 148. Twisted portion of a tube of the same kind, and from a similar locality in the crystalline lens of the same fœtus. The corpuscles were red, and in a state which in other respects, also, was similar to that of the corpuscles in fig. 147.

Fig. 149. Ox; fœtus of eighteen inches. From the edge of the crystalline lens. Portion of a tube filled with corpuscles having the appearance of blood-corpuscles in a more or less altered state. These are in outline only. Some were round; others elliptical. Most of them exhibited traces of division into discs, which in two instances have been represented in the figure. Here and there, these corpuscles were still blood-red; but the most advanced of them had become pale.

Fig. 150. Ox; fœtus of eighteen inches. From the edge of the crystalline lens. Portion of a tube filled with corpuscles having the appearance of more or less altered blood-corpuscles. Those on the side α were blood-red; while those on the side β had become pale. The latter were also elongated, and dividing into discs. In some parts, the corpuscles seemed to be arranging themselves in lines, as if to form fibres.

Fig. 151. Sheep; fœtus of six inches. From the edge of the crystalline lens. Portion of the tube filled with corpuscles having the appearance of altered and enlarged blood-corpuscles. In outline. These corpuscles exhibited a brilliantly pellucid object in the situation of the original cavity or depression. In some instances, this pellucid object seemed double. The surrounding part of the corpuscles was blood-red.

Fig. 152. Ox; fœtus of eighteen inches. From the edge of the crystalline lens. Portion of a tube filled with corpuscles having the appearance of blood-corpuscles in greatly enlarged and altered states. (See the description of fig. 142.) α, β. Several of the many pellucid spaces, occupying the situation, apparently, of the original cavity or depression in the corpuscles. Some of these spaces were very minute; and others, β, so large, that they seemed to have resulted from the coalescence of several smaller ones. By degrees, indeed, the tube may thus become colourless in its whole diameter; the red colouring matter, γ (which is situated between the pellucid spaces), having disappeared. The figure, which is chiefly in outline, represents the red colouring matter only at the upper part (γ); where a trace is seen of the division between the corpuscles. δ. There is visible in some of the pellucid spaces, a minute, highly refracting object, apparently an orifice, which at δ, δ, seemed to communicate with the exterior of the tube. ε. Outline of corpuscles having the same appearance as young corpuscles of the blood, observed with the foregoing. One of these, it will be seen, did not exceed $\frac{1}{800}'''$ in length.

Fig. 153. Sheep; fœtus of six inches. From the crystalline lens. Outline of pale cells. One of them was seen to be filled with discs, which also are represented in outline.

Fig. 154. Ox; fœtus of ten inches. From the crystalline lens. Pale cells, for the most part in very early stages of formation, and exceedingly minute. The cells are in outline, except their nuclei, a few only of which (nuclei) have been delineated. In many of the cells, however, a nucleus was not discerned. And this indeed was in most instances the case. α. Objects composed of discs. The outer portion (exceedingly minute discs) of such objects appears to separate from the rest, to form the membrane of a cell; the remainder being the nucleus of the cell. β. The cell-membrane formed. γ. Nucleated cells more advanced. The other cells in this figure are in outline. Some of them, δ, are arranged in rows; which was observed in many instances to be the case. Cells even of the minuteness of those in this figure, often seem to contain discoid objects; especially if the nucleus has disappeared.

Fig. 155. Ox; fœtus of eighteen inches. From the edge of the crystalline lens.

Corpuscles, having the same appearance as corpuscles of the blood, passing into pale cells,—the elements of the crystalline. α. Outline of two of these corpuscles, which were but little changed. Their contour was irregular. Corpuscles in such states, when required to pass through a minute space, undergo remarkable alterations in their form, and are seen to be susceptible of extreme attenuation. β. Composed of discs. Two brilliantly pellucid orifices are seen on one side; this being the situation of the originally single orifice in the corpuscle or disc, before its division into other discs. This is the situation, also, of the nucleus of the future cell, if formed. γ. Flattish corpuscle, composed of discs, and blood-red. δ, δ. Corpuscles resembling γ, but larger, and in little more than outline. ε, ε. Nucleated cells. The nuclei are dividing into discs. ζ. An orifice in the nucleus, apparently communicating with the exterior of the cell. This orifice would have been the situation of the future nucleus, after the division of the present one into discs; which discs were already formed, but not separated. η. Besides a nucleus, consisting of discs, the cell exhibits discs in its cavity. Only two of these are represented in the drawing. All the objects in this figure presented red colouring matter; which in α, β, γ, δ pervaded the entire object; but in ε, ζ, and η, was confined to the nucleus.

Fig. 156. Ox; fœtus of ten inches. From the crystalline lens. Outline of cells, the elements of the crystalline, for the most part exceedingly pale. They were altered corpuscles having the same appearance as corpuscles of the blood; and presented states which, in general (not in every instance), were more advanced than those in fig. 155. α. The contour irregular, from the incomplete formation of the membrane, which discs were coalescing to produce. The dark round object is the future nucleus. In it is an orifice, communicating with the still incipient cell. This orifice indicates the situation of a future nucleus, to form as the existing one divides into discs. β. A state resembling α, but the nucleus already composed of discs. γ. The nucleus has divided into two portions, each of which consists of incipient discs. δ, δ. A nucleus not visible. But the interior of the cell presented discs; too indistinctly, however, to admit of delineation. Such was the case also with the cell γ.

PLATE XXV.

Fig. 157. Ox; fœtus of ten inches. From the crystalline lens. Incipient fibres, forming by the coalescence of cells of the same kind as some of those in figs. 153, 154, 155, 156; which are derived from corpuscles having

the same appearance as corpuscles of the blood. These incipient fibres are in outline. α. An orifice in the nucleus, probably communicating with the exterior of the cell. One part of the fibre β still presented a bead-like appearance. In another part, the cells had fully coalesced into a cylinder. The latter was the case throughout the fibres γ. In some of these latter fibres, peripheral objects were still seen (par. 178.). δ. A cell filled with discs; a nucleus not being observed in this cell.

Fig. 158. From the same crystalline lens. Outline of incipient fibres. See the description of the preceding figure. α. An orifice in the nucleus, communicating with the exterior of the cell. Nuclei were not observed in any of the cells at the upper part of this figure; the cause being probably that these cells were more advanced than those in the lower line, and that their nuclei had been divided into the contents of the cells. β. Deficiency in the size of the cells, made up for by the number present in the diameter of the fibre.

Fig. 159. From the crystalline lens of the opposite eye in the same fœtus. Cells such as those in the two preceding figures,—but, generally speaking, larger—arranging themselves to form a fibre of the crystalline. Some of these cells presented a nucleus. In others, no nucleus was seen. The nucleus, as elsewhere, appeared to be composed of discs. The nucleus on the left consisted of two discs; and each of these presented indications of a subdivision into minuter discs. Two of the cells entering into the formation of the fibre in this figure, were very minute compared with the rest.

Fig. 160. Stone-chat (*Motacilla rubicola*, Linn.). From the testis, after maceration for a night in water. Altered corpuscles having the appearance of blood-corpuscles. They were blood-red, consisted of discs, and were apparently progressing to form fasciculi of spermatozoa. The smallest is in outline.

Fig. 161. Yellow Bunting (*Emberiza citrinella*, Linn.). From the testis. Altered corpuscle having the appearance of a blood-corpuscle, composed of discs which were deep red; and apparently in the course of forming a fasciculus of spermatozoa.

Fig. 161½. Rabbit; killed two hours *post coitum*. From the vagina. α. Several spermatozoa, apparently composed of discs, the number of which discs appeared greater in some than in others. β. An object composed of discs. On the left, this object presented a part much darker than the rest, apparently an orifice, in which the discs were seen with great distinctness. γ. Outline of an object of the same kind, but smaller. The darker part obviously communicated with the exterior by an orifice, γ γ, in which the discs were exceedingly distinct, as well as at the

part circumscribed by a dotted line; the latter part being continued from the orifice ($\gamma\ \gamma$,) to the centre of the object γ, and brought into view by depressing the instrument. δ. A larger object, being either an advanced state of β and γ, or else containing several objects such as these. δ Seemed to be composed of discs, among which were seen some with caudal appendages,—probably spermatozoa. δ Was circumscribed by a membrane. (Acetic acid.)

Fig. 162. Stone-chat. Objects from the testis; namely, α, altered corpuscles having the same appearance as corpuscles of the blood,—and β, γ, δ, portions of spermatozoa, forming out of such altered corpuscles. Red colouring matter visible in all. The corpuscles composed of discs. β. Part of two spermatozoa, in the course of formation out of discs. γ. Discs which appeared to have coalesced at their extremities and sides. At the upper part, and on the left side, of this object, is seen a partially formed spermatozoon. It would thus seem that the spermatozoa are here formed by division of the discs; and this mode of origin is no doubt connected with their spiral form. δ. Portion of a spermatozoon completely formed.

Fig. 163. From the testis of the same Bird, after a night's maceration in water. α. The large corkscrew-like extremity of a spermatozoon. β. Outline of two similar objects, the position of which, in relation to each other, was such as to suggest the idea that the division of the discs, for the formation of the spermatozoa, was either incomplete, or so recent that the spermatozoa were still imperfect; and that their position had not changed. The objects in this figure were blood-red.

In the figures of the ovum (figs. 164 to 173.) the letter *c* denotes the germinal vesicle, *g* the discs of the ovisac, and *h* the membrane of the ovisac†.

Fig. 164. Wryneck (*Yunx Torquilla*, Linn.). Corpuscle having the same appearance as a blood-corpuscle, very much enlarged, and filled with young corpuscles. Each of these young corpuscles is an ovum (including the ovisac) in a rudimental form. These objects are for the most part in outline; but three of them are in a more finished state. *g*. Discs, into which a portion of the young corpuscle has divided. In some parts these discs were quite red; in others pale. *c*. Germinal vesicle, in the situation of the original depression existing in the young corpuscle, when the latter was a disc. In the young corpuscle on the right, *c* is still a mere disc, having a diameter of $\frac{1}{700}'''$. At a certain part, the membrane of *c* presents an orifice, indicating the situation of the future germinal spot. (Acetic acid.)

Fig. 165. From the same ovary. Corpuscles having the same appearance as young

† The same letters are here used, and they denote the same objects, as in my memoirs on Embryology, *ll. c.*

blood-corpuscles, forming ova. They differed from the objects of the preceding figure in retaining more the appearance of *discs*; the transition from which is here very obvious,—α having apparently undergone no further perceptible change than that of becoming round. β. The outer portion now consists of discs,—the inner part being itself a disc, the future germinal vesicle. γ. A more advanced state; the part *c*, corresponding to the central disc of β, being now the germinal vesicle. In the object not marked, two discs seemed to occupy the situation of *c* in γ. (Acetic acid.)

Fig. 166. From the same ovary. Part of a group of corpuscles having the same appearance as young blood-corpuscles, just escaped from a parent corpuscle, such as that in fig. 164. They were blood-red, and appeared to be membranous at the surface. These objects are rudimental ova. The letters as above. A distinct orifice in *c*. (Acetic acid.)

Fig. 167. From the same ovary. Part of a group of objects of the same kind, colour, origin, and general appearance, except that they were not membranous at the surface. One of the germinal vesicles, *c*, is larger than the rest; and the orifice in it is of considerable size. (Acetic acid.)

Fig. 168. From the same ovary. State of the rudimental ovum (altered corpuscle having the same appearance as a blood-corpuscle) rather more advanced. The germinal vesicle (*c*) was larger, and the discs *g* were dividing into minuter discs. These discs were quite red. (In one instance, in which the size of the rudimental ovum was about the same, the discs *g* had begun to coalesce for the formation of the membrane of the ovisac.) (Acetic acid.)

Fig. 169. From the ovary of the same Bird. Conditions which, excepting α, are still more advanced. α. Still blood-red. β. In outline. Redness diminished. Globules between the discs. γ. Chiefly in outline. Each of the discs presented a cell-like object in the situation of its original depression. δ. Blood-red. The discs *g* dividing into smaller discs. The germinal vesicle (*c*) obscurely seen in the interior.

Fig. 170. From the ovary of the same Bird. Portion of an ovisac, elliptical in form, and $\frac{1}{40}'''$ in length. Partly in outline. *h*. Membrane of the ovisac, forming out of the discs *g*, which for this purpose are dividing into minuter discs. *g*. Quite red, and becoming pale in *h*. *c*. Portion of the germinal vesicle.

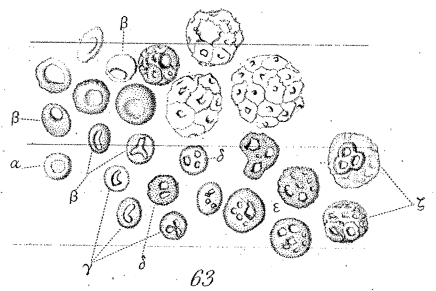
Fig. 171. From the same ovary. Similar objects in a more advanced state. Length of the ovisac $\frac{1}{20}'''$. The discs *g*, within the ovisac, were smaller than those in fig. 170; having undergone division. Where lying around the germinal vesicle (*c*), they were smallest, had a high refracting power, and were quite red. Proceeding from this situation towards the mem-

brane, *h*, of the ovisac, we find them increasing in size, losing their high refracting power, and becoming pale. Where entering into the formation of the membrane *h*, they were largest, and undergoing a further division. Even the outermost of these discs *g*—those coalescing to form *h*—though very pale, presented a tinge of red.

Fig. 172. From the same ovary. Portion of the membrane of an ovisac, which was elliptical, and $\frac{1}{3}'''$ in length, as it lay crushed under a piece of glass. It still presented a pale tinge of red, as well as traces of some of the discs of which this membrane is composed.

Fig. 173. Canary bird (*Fringilla Canaria*, Linn.). Part of an ovisac ($\frac{1}{30}'''$ in diameter), with its contents; the whole derived from a corpuscle having the same appearance as a corpuscle of the blood, and the whole still more or less red. Respecting *g* and *h*, see the explanation of the preceding figures. (The figure does not represent the membrane of the yelk.) *c*. Germinal vesicle, containing reddish discs; the minuter of which surround a central disc, which is the newest solid part. In the centre of the latter there is a dark point, representing (by refraction) a fluid space,—the situation of the future germinal spot.

Corpuscles of the Blood.



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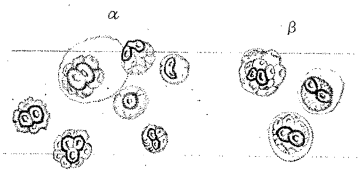

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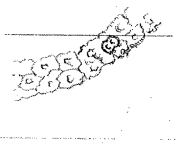

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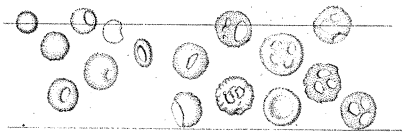

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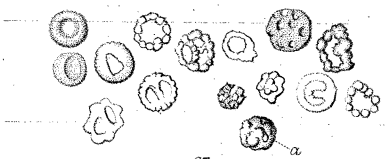

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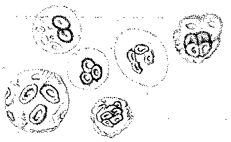

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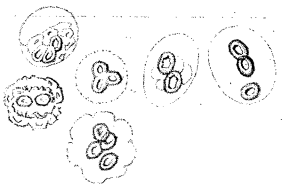

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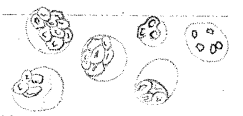

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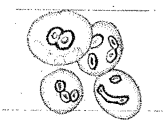

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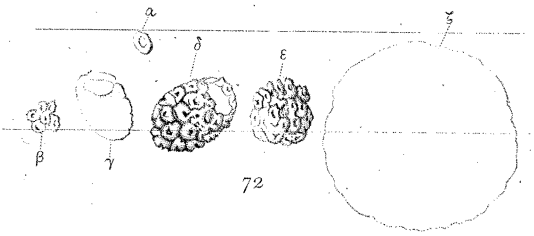

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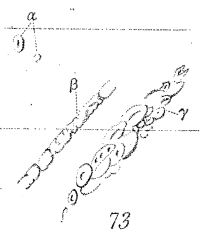

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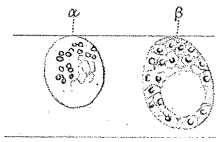
74
Tadpole 6‴



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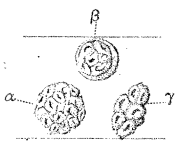

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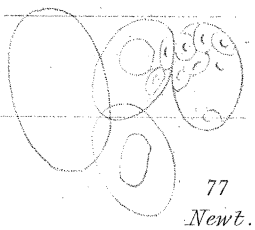

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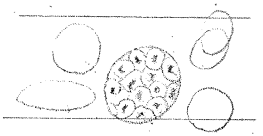
Newt.



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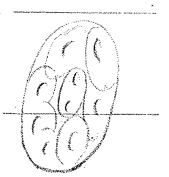
Newt.



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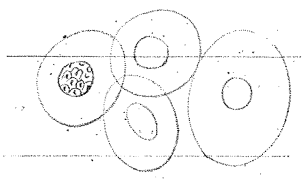
Newt.
Acetic Acid.



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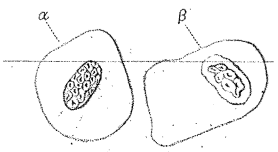
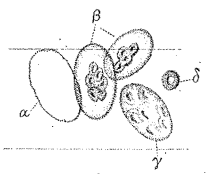
Newt.
Nitrate of Silver.



81
Newt.
Corrosive Sublimate.



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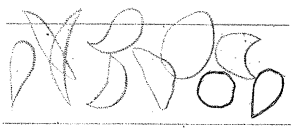
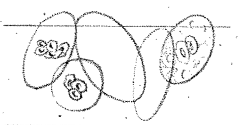
Green Lizard.



83
Fœtal Duck.



84
Fœtal Duck.

All the Objects are magnified 600 Diameters.—(The horizontal Lines are described at the foot of Plate XVII.)

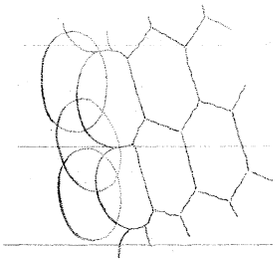
Fig.s 63 to 67. Nucleus of the Blood-corpuscle passing into the Pus-globule.

68 to 73. Globules, Cells, &c. of Mucus—derived from Corpuscles having the same appearance as Corpuscles of the Blood.

74 to 84. Blood-corpuscles, and Objects found along with them.

Ad. Nat. del. Martin Barry. J. Basire sculp.

Corpuscles of the Blood.



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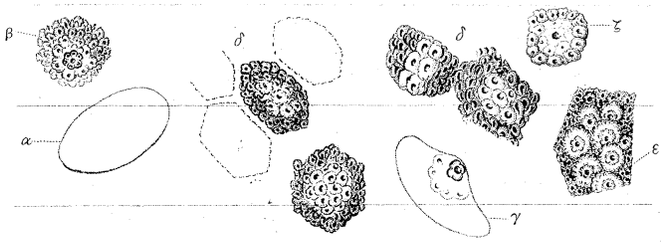

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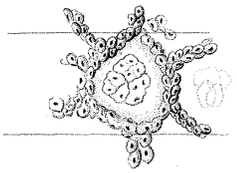
87



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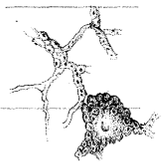

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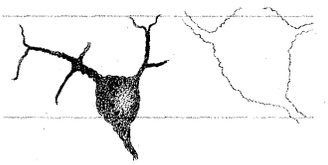

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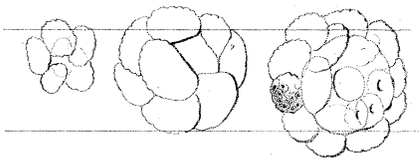

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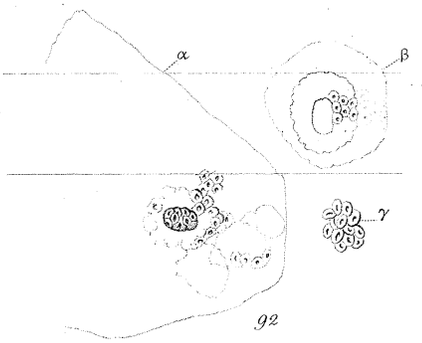

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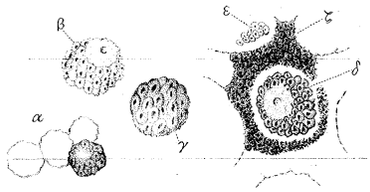

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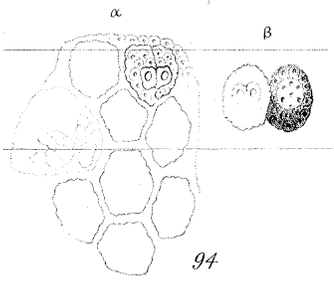
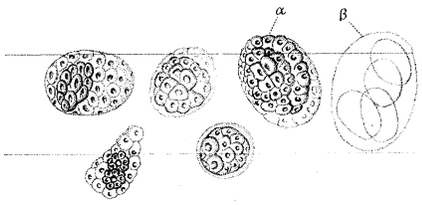
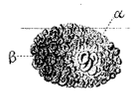


94

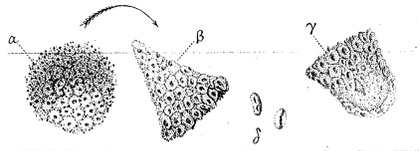


95



96

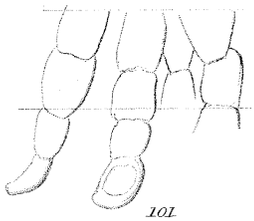
97



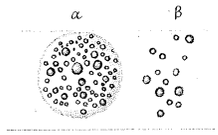
98

99

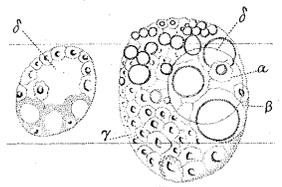
100



101



102



103

All the Objects are magnified 600 Diameters.—*(The horizontal Lines are described at the foot of Plate XVII.)*

Fig^{s} *85 to 94. Epithelium-tables, cells, and cylinders*—*and Pigmentum nigrum* { *Derived from Corpuscles having the same appearance as Corpuscles of the Blood.*

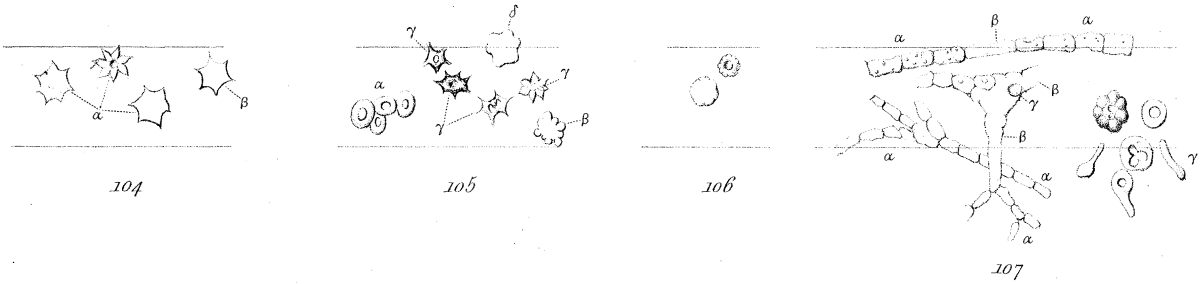
95. Blood-corpuscles, altered.

96 to 100. Epithelium cylinders

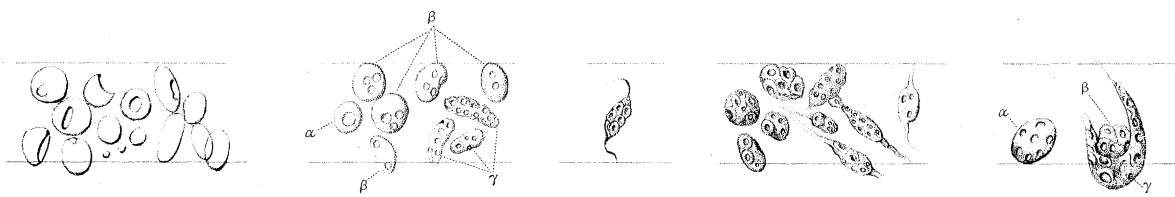
101. Ciliary Processes } *Ditto.*

102, 103. Miscellaneous Objects

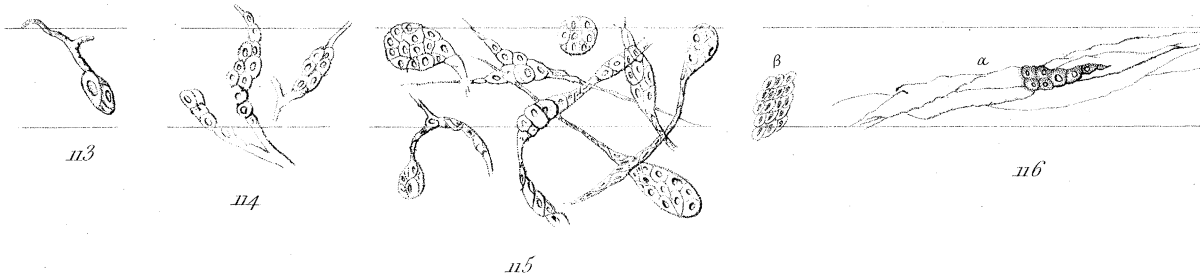
Corpuscles of the Blood.



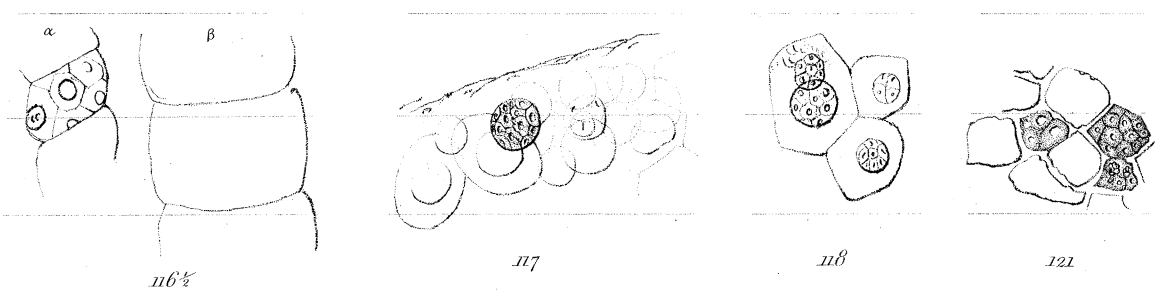
104 105 106 107



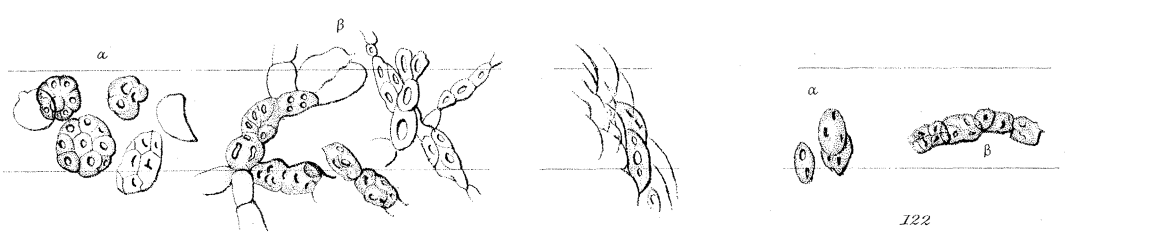
108 109 110 111 112



113 114 115 116



116½ 117 118 121



119 120 122

All the Objects are magnified 600 Diameters.—*(The horizontal Lines are described at the foot of Plate XVII.)*

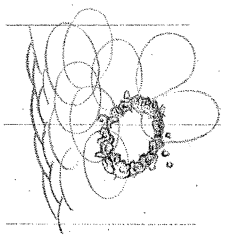
Figs 104 to 106. *Ciliated Nuclei of Blood-corpuscles, Young Blood-corpuscles, &c.*

107. *Elements of Capillaries, &c.*

108 to 116. *Elements of Cellular Tissue.* } *Derived from Corpuscles having the same appearance as Corpuscles of the Blood.*

116½ to 122. *Elements of Cartilage.*

Corpuscles of the Blood.



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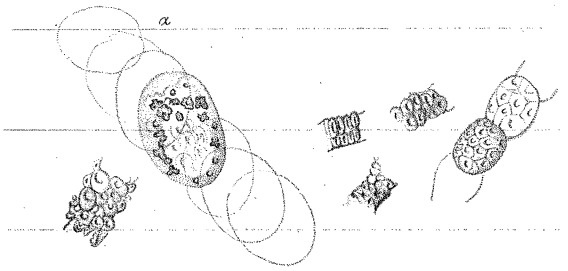
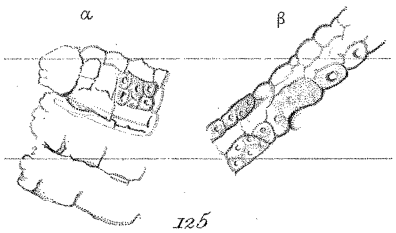


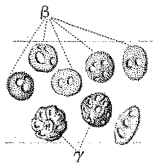
124



125

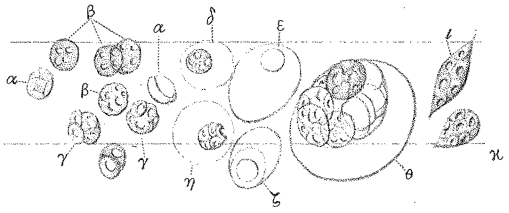
126

127



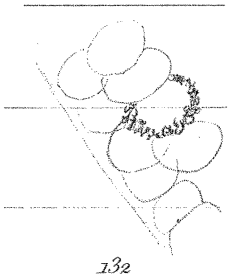
128

129

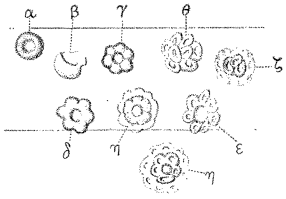


130

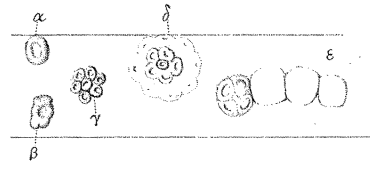
131



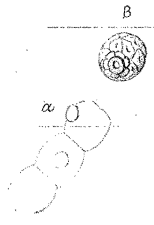
132



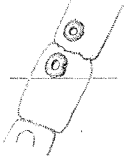
133



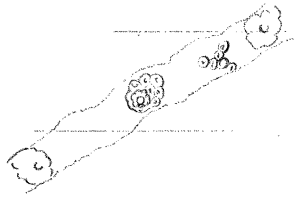
134



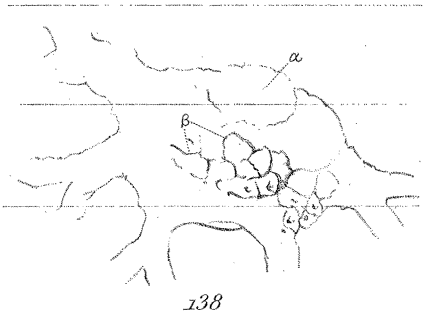
135



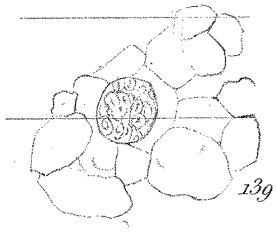
136



137



138



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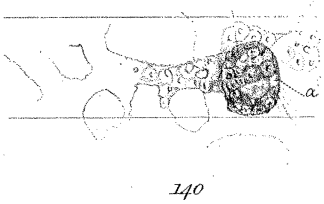
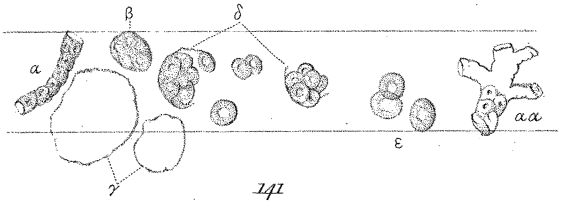


140



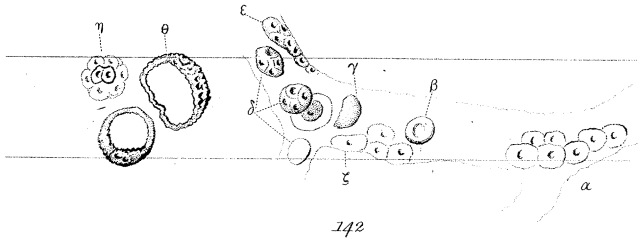
141

All the Objects are magnified 600 Diameters. (*The horizontal Lines are described at the foot of Plate XVII.*)

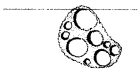
Figs. 123 to 125. *Elements of the Optic Nerve.*
126 to 131 ..... *Retina.*
132 ..... *Spinal Chord.*
133, 134 ..... *Brain.*
135 to 137 ..... *Muscle.*
138 to 141 ..... *Crystalline Lens.*

} *Derived from Corpuscles having the same appearance as Corpuscles of the Blood.*

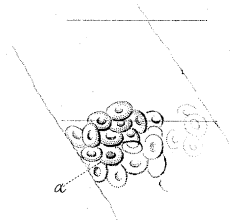
Corpuscles of the Blood.



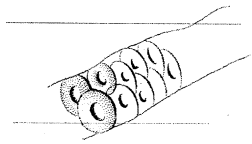
142



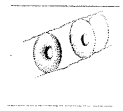
143



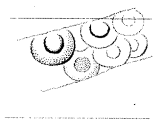
144



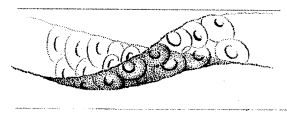
145



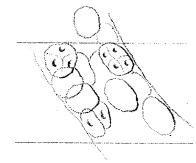
146



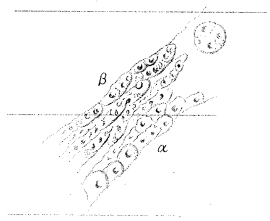
147



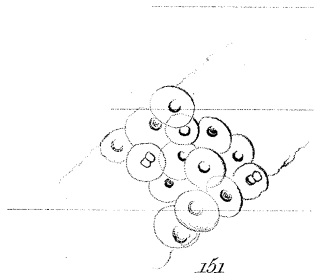
148



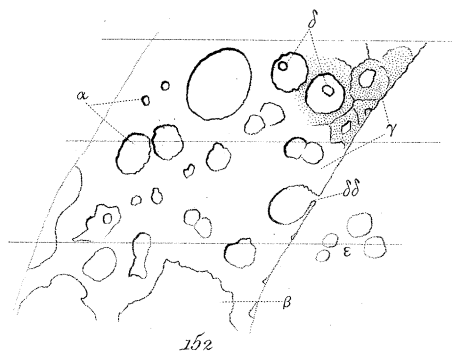
149



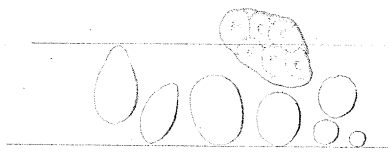
150



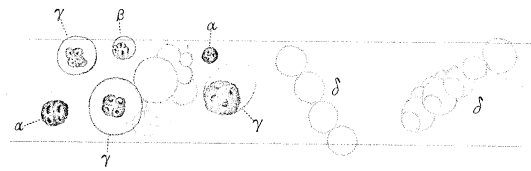
151



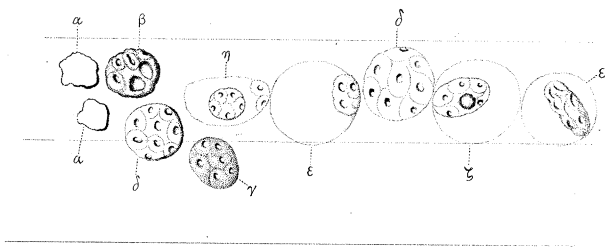
152



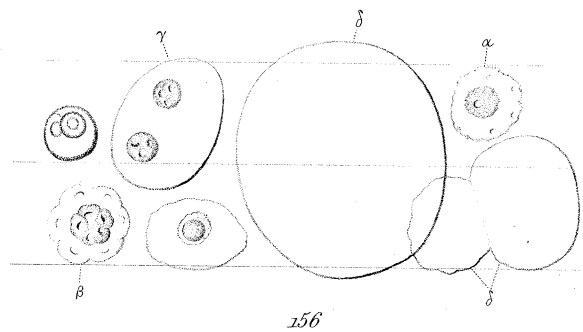
153



154



155

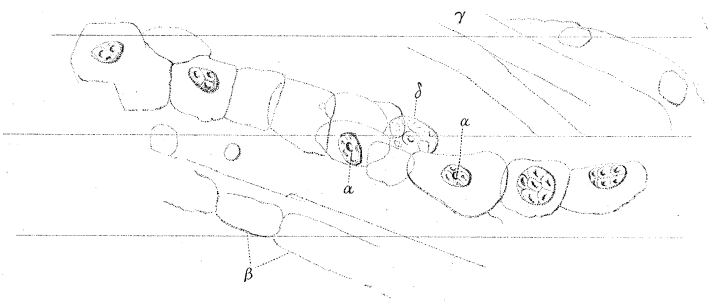


156

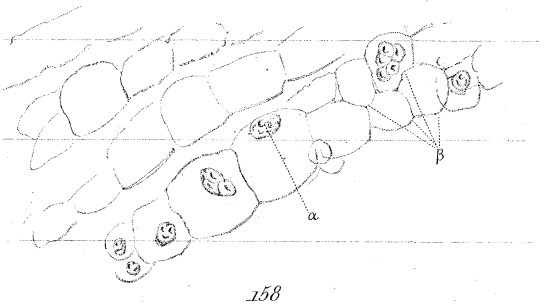
All the Objects are magnified 600 Diameters.—*(The horizontal Lines are described at the foot of Plate* XVII.*)*

Elements of the Crystalline Lens, derived from Corpuscles having the same appearance as Corpuscles of the Blood.

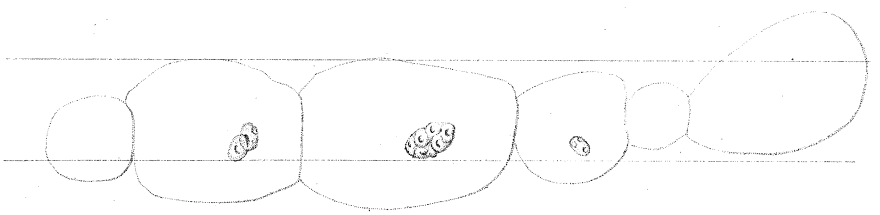
Corpuscles of the Blood.



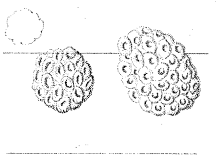
157



158

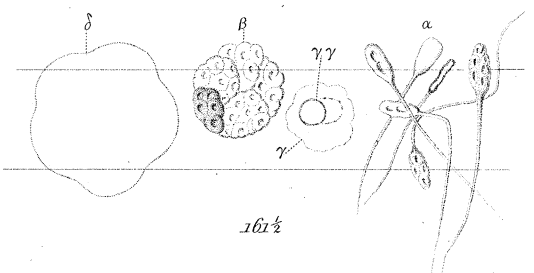


159

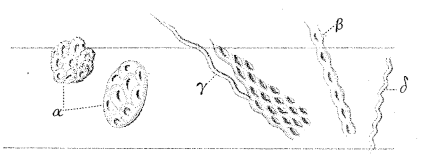


160

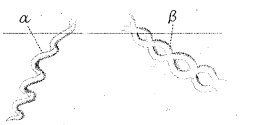
161



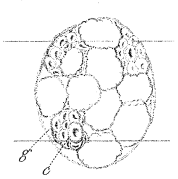
161½



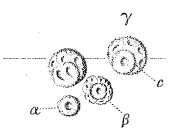
162



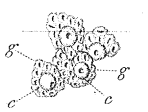
163



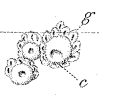
164



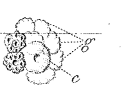
165



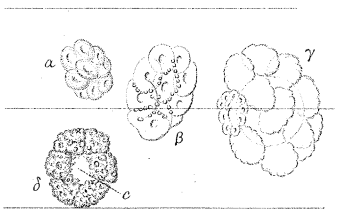
166



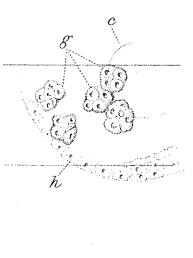
167



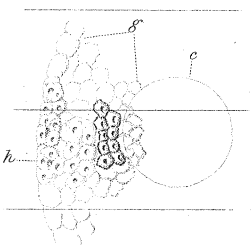
168



169

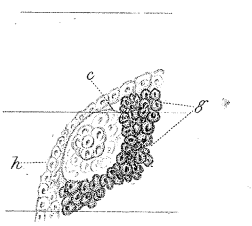


170



171

172



173

All the Objects are magnified 600 Diameters. *(The horizontal Lines are described at the foot of Plate XVII.)*

Fig^s 157 to 159. Elements of the Crystalline Lens ....
160 to 163. Elements of the Spermatozoa ....
164 to 173. Elements of the Ovum ....
} Derived from Corpuscles having the same appearance as Corpuscles of the Blood.

Ad. Nat. del. Martin Barry.

J. Basire sculp.